Medical Lib.

NOV 2 1921

VOLUME 22 NUMBER 3

AMERICAN JOURNAL

OF

DISEASES OF CHILDREN

EDITORIAL BOARD

H. F. HELMHOLZ, Rochester, Minn.

L. EMMETT HOLT, New York City DAVID M. COWIE, Ann Arbor, Mich.

FRITZ B. TALBOT, Boston EDWIN E. GRAHAM, Philadelphia

JOHN HOWLAND, Baltimore

SEPTEMBER, 1921

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO, ILLINOIS. | ANNUAL SUBSCRIPTION, $6.00

Entered as Second-Class Matter, January 4, 1915, at the Postoffice at Chicago, Illinois, Under Act of Congress of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on June 14, 1918.

CONTENTS OF PREVIOUS NUMBERS

MAY, 1921. NUMBER 5

Concerning the Nature of "Protozoan-Like" Cells in Certain Lesions of Infancy. Ernest W. Goodpasture and Fritz B. Talbot, Boston.

Report on a Case of Gaucher's Splenomegaly. N. Chandler Foot, M.D., and William E. Ladd, M.D., Boston.

A Case of Idiopathic Hemorrhagic Sarcoma of Kaposi. Stafford McLean, M.D., New York.

Influenzal Meningitis, with Report of a Case. Isaac A. Abt, M.D., and I. Harrison Tumpeer, S.M., M.D., Chicago.

A Preliminary Report of the Study of Breast Feeding in Minneapolis. Julius Parker Sedgwick, B.S., M.D., Minneapolis.

The Presence of Sugar in the Urine of New-Born Infants Before the Intake of Foods. Frances Millikin, Chicago.

JUNE, 1921. NUMBER 6

Standards of Basal Metabolism in Normal Infants and Children. Fritz B. Talbot, M.D., Boston.

The Reflexes in Early Infancy. Charles W. Burr, M.D., Philadelphia.

The Factor of the Position of the Diaphragm in Roentgen-Ray Diagnosis of Enlarged Thymus. H. J. Gerstenberger, Cleveland.

Empyema in Children, with Analysis of One Hundred and Seventy-Two Cases. William E. Ladd, M.D., and George D. Cutler, M.D., Boston.

JULY, 1921. NUMBER 1

The Degree of Immunity to Diphtheria Insured by a Negative Schick Test. William H. Park, M.D., New York.

The Range and Distribution of Blood Pressures in Normal Children. Clinical Application of Statistical Methods to the Interpretation of Deviation from the Normal Average. Harold K. Faber, M.D., and Charles A. James, M.D., San Francisco.

The Tonsils and Scarlet Fever. Jesse G. M. Bullowa, M. D., New York.

AUGUST, 1921. NUMBER 2

Calcium and Phosphorus in the Serum in Relation to Rickets. John Howland and Benjamin Kramer, Baltimore.

A Contribution to the Topographic Anatomy of the Thymus Gland, with Particular Reference to Its Changes at Birth and in the Period of the New-Born. Gustave J. Nohrer, M.A., Minneapolis.

Lesions of the Corpus Striatum in Childhood, with Report of Clinical Cases Illustrating Various Syndromes. Bronson Crothers, M.D., Boston.

A Further Contribution to the Study of Pyloric Stenosis. L. W. Sauer, M.D., Evanston, Ill.

The Fragility of the Red Blood Corpuscles in Infectious Diseases. Roy M. Greenthal, M.D., and William S. O'Donnell, M.D., Ann Arbor, Mich.

Toxic Symptoms in Infants and Children with Gastro-Intestinal Manifestations. Herman Schwarz, M.D., and Jerome L. Kohn, M.D., New York.

Diphtheria Among Immunized Children. S. A. Blauner, M.D., New York.

Eosinophilia Occurring in Chorea. Harry Calvin Berger, M.D., Kansas City, Mo.

Necropsy Findings in New-Born Infants. Margaret Warwick, St. Paul.

A Case of Meningococcus Meningitis with Obstructive Hydrocephalus in the Newly Born. J. Harold Root, M.D., Waterbury, Conn.

Progress in Pediatrics:
Review of the Ear, Nose and Throat Literature for the Year 1919. G. W. Boot, M.D., Chicago.

Changes in the Form and Dimensions of the Chest at Birth and in the Neonatal Period. Richard F. Scammon, Ph.D., and William H. Rucker, B.S., Minneapolis.

The Absorption of Fluid Injected into the Peritoneal Cavity. B. S. Denzer, M.D., and A. F. Anderson, M.D., New York.

The Physical Development of Tuberculous Children. M. L. Blatt, M.D., Chicago.

Progress in Pediatrics:
Resumé on the Circulatory System Literature of 1920. Henrietta Calhoun, M.D., Iowa City.

Some Observations on the So-Called Inanition Temperature of the New-Born. C. G. Grulee, M.D., and B. E. Bonar, M.D., Chicago.

Clinical Department:
Congenital Absence of Middle Portion of Esophagus. Frank C. Neff, M.D., Kansas City, Mo.

Progress in Pediatrics:
Recent Progress in Anatomy, Physiology and Pathology of Childhood. James B. Holmes, M.D., Baltimore.

Book Review.

Congenital Aneurysmal Dilatation of Ductus Botalli. David M. Dry, M.D., Philadelphia.

An Interpretation of the Seasonal Variation of Rickets. Alfred F. Hess and Lester J. Unger, New York.

Studies of Infant Feeding. XIII. The Caseins of Cow's Milk and Human Milk in Their Relation to Infant Feeding. The Action of Rennin on Casein. Alfred W. Bosworth, Boston.

Vital Capacity of the Lungs of Children. Paul W. Emerson and Hyman Green, Boston.

A Rapid Clinical Method for the Determination of the Reducing Substance in the Cerebrospinal Fluid: The Methylene-Blue Method. Michio Kasahara and Shunjiro Hattori, Kyoto, Japan.

Book Reviews.

COPYRIGHT, 1921, BY THE AMERICAN MEDICAL ASSOCIATION

American Journal of Diseases of Children

VOL. 22 SEPTEMBER, 1921 No. 3

DEMONSTRATION OF FOOD PROTEINS IN HUMAN BREAST MILK BY ANAPHYLACTIC EXPERIMENTS ON GUINEA-PIGS

THEIR PROBABLE RELATIONSHIP TO CERTAIN DISEASES OF THE NURSING INFANT *

A PRELIMINARY REPORT

W. RAY SHANNON, M.S., M.D.
Associate in the Department of Pediatrics, Miller Hospital Clinic
ST. PAUL

Our forefathers believed that foods ingested by the nursing mother might affect the child through the breast milk. We, however, have discarded that belief almost universally, and have relegated it to the shelves of superstition simply because we have not succeeded in proving it to be true. Having seen several cases of food disturbance in infants which it seemed could have come only through breast milk, I determined to investigate this subject to see if I could prove by anaphylactic tests that such was the case. It is the purpose of this paper to record the results of this investigation.

Generally speaking, the subject of diet for the nursing mother is passed over lightly. The most widely accepted view at the present time is that she may eat whatever agrees with her. "The mother may eat whatever is good for the father," is a very common expression. Pfaundler and Schlossman's textbook [1] contains the statement that "a nursing mother may eat whatever she pleases." Abt [2] says, "Nearly every writer on subjects of maternal nursing has declared against the view that certain foods ingested by the mother are capable of producing disturbance in the infant through the breast milk." These statements unquestionably crystalize the general sentiment of those interested in the subject of maternal nursing today.[3] Restrictions, if there be any, are made for fear unrestricted diet might result in intestinal upsets in the mother and not because it is thought that harm might come to the

* Received for publication, April 25, 1921.
* Published from the Miller Hospital Clinic.

1. Pfaundler and Schlossman: English translation **1**:356, 1912.

2. Abt: Facts and Fallacies About Breast Feeding, St. Paul M. J. p. 281, (April) 1915.

3. Foote, J.: Washington M. Ann. **16**:82 (March) 1917. Durand, J. I.: Northwest Med. **15**:89 (March) 1916. Greer, B. E.: Texas State J. M. **13**:213 (Oct.) 1917.

infant through the breast milk. Thus Holt [4] makes mention of the fact that salads and highly seasoned foods should be avoided, not so much because they upset the child as because they are apt to upset the digestion of the nurse.

While this seems to be the prevailing opinion, the literature is not devoid of warnings that blind adherence to such a principle might, in certain cases, prove disastrous.[5] Thus Rotch,[6] in 1901, says "Certain vegetables and sometimes fish will, in individual cases, affect the milk and cause discomfort to the baby." Griffith [7] also states that in exceptional cases, where the mother may have idiosyncrasies to certain foods, the eating of such foods may affect the breast milk so as to cause disturbance to the infant. Colburn [8] makes a similar statement.

The preceding statements, apparently, have been largely in the nature of impressions, and have not been followed up by any convincing proof. Talbot,[9] however, mentions a case in which a very severe eczema cleared up on the mother's discontinuing the eating of chocolate and recurred on her again eating that food.

The most convincing arguments for the transmission of foods eaten by the mother to the infant through the breast milk are presented by E. S. O'Keefe.[10] He found that some of his nursing infants with eczema gave positive skin reactions to proteins they had never eaten. One infant was susceptible to cow's milk casein, another to egg and oats, still another to codfish, and several others to egg protein. In some of the cases, recovery was prompt on the removal of the offending protein from the mother's dietary, while in other cases it was slow. Still other cases showed no improvement at all. The author suggests that a biologic investigation might be of interest to ascertain whether or not the protein of the foods could be identified in the breast milk.

During the past winter the following case came under my care.

REPORT OF CASE

A male infant, 7 months old, was brought in by the mother because of a profuse skin eruption, involving practically the entire body. This eruption had first been noticed about two weeks previously. It first appeared on the backs of the hands in the form of groups of small papules resembling mosquito bites. From the backs of the hands it had spread to the forearms, arms, face and chest, and finally over the entire body, being most marked on the extremities. The papules in many cases would turn into vesicles which, when rubbed off by scratching, became covered with crusts. Some became filled with pus, probably due to secondary infection.

4. Holt: Diseases of Children, 1917, p. 142.
5. Mulherin: J. A. M. A. **75**:855 (Sept. 20) 1920. (See discussion by Dr. Chas. J. Bloom). Westcott: Am. J. Obst. **78**:55.
6. Rotch: Pediatrics, 1901, p. 137.
7. Griffith: Diseases of Infants and Children, 1919 **1**:105.
8. Colburn, W. B.: Nebraska State M. J. **4**:243 (Aug.) 1919.
9. Talbot, F. B.: Med. Clin. N. America, **1**:985 (Jan.) 1918.
10. O'Keefe, E. S.: Boston M. & S. **182**:569 (Nov. 11) 1920.

Past History.—With the exception of a few points the past history was negative. The feeding had been irrational, the baby having been fed every time he cried. Off and on, of late, the mother had been giving cream of wheat, oatmeal, cow's milk, cream, potatoes, tea and some beef, apparently helping the child from the family table. In spite of this the child had thrived, being somewhat overweight and having had no illnesses, more than occasionally frequent stools and a few colds, until the onset of the present illness.

Physical Examination.—Aside from the skin condition the physical examination was essentially negative. Over the entire body was a profuse papular eruption. This was very marked over the backs of the hands and fingers, forearms, scalp and neck. The papules were largely confluent over these areas, giving them a thickened, swollen appearance. Over the trunk, thighs, legs, feet, the upper arms and face the lesions were less numerous. One patch only was present on the back and this was in the lower left lumbar region. The eruption was present also on the ears, palms and soles, and on the penis and scrotum. There were no lesions in the mouth.

The Papules.—In size, the papules varied from pin-head to one-half the size of a bean. The majority of papules were capped by vesicles which also varied in size from pin-point, topping the papules, to one-half the size of a bean and replacing it entirely. The largest vesicles were seen where the eruption was thickest and on the palms and soles. All vesicles were tense and filled with fluid of varying degree of turbidity. The larger ones were thick walled.

In the old lesions, the papules were dark red in color. Frequently, here, the vesicles had been replaced by black crusts. Lesions of this type were scattered over the entire body. In the scalp a few lesions were infected, and presented the appearance typical of impetigo contagiosum, probably due to secondary infection.

The early papules were whitish or pinkish in color and often appeared in clusters or groups. They were found interspersed with the older lesions over the entire body. They seemed to itch moderately, though not so severely as some forms of eczema. To palpation they felt shotty, similar to the early lesions of smallpox, which some of the papules strongly resembled.

Diagnosis.—Apparently the disease was in the nature of a chronic urticaria, and probably due to some food eaten by the patient. Therefore, the child was taken off all artificial foods, and local applications were applied for a period of one week with no improvement. In fact, the eruption became more profuse. It then seemed advisable to place the child on a hospital regime and to attempt to find the underlying cause. This was done.

Treatment.—After a study of the diets of mother and patient the latter was tested by the cutaneous method with the following proteins; cow's milk casein, egg white, egg yolk, banana, oats, potato, corn, beef, wheat, peas, rice, barley, carrots, tomato and pork. Definitely positive reactions were obtained to egg white, egg yolk and oats. Questionable reactions were obtained in the cases of banana, wheat, peas and tomato. The mother asserted that the baby had never received eggs, bananas, peas or tomato in his diet. The mother was instructed to eat no egg or food containing egg, oats, banana, wheat, peas, rice or tomato, and the baby was held to a diet of breast milk alone.

Clinical Course.—Improvement was very rapid so that in three days all the lesions had lost their ruddy color and were covered by thin colorless crusts. No new lesions had appeared. This improvement continued till the fifth day when the mother thought the infant so well recovered that she signed him out against advice.

Soon after getting the child home the mother began giving him crusts of bread. She herself began eating wheat bread toast for breakfast. On the third day after leaving the hospital new lesions began to appear. The mother lost heart in the matter of following directions and the condition of the skin reverted to its former state, although to a less degree.

Comment.—It seemed that the breast milk must be responsible in some way for the eruption, most probably by carrying the proteins to which the infant was suceptible. An analytical investigation by means of anaphylactic reactions on guinea-pigs was, therefore, undertaken in an attempt to prove the presence of some of these proteins in the breast milk after they were eaten by the mother.

Before proceeding with the experimental work, it might be well to discuss, briefly, the underlying principles on which the investigation was based.

Anaphylaxis is a phenomenon occurring in the animal body, or under certain conditions in the excised parts, as a result of the introduction of a foreign protein after the animal has been sensitized to that protein. Sensitization may be inherited, passively acquired, or actively attained. The latter form results within a variable period of time, usually in at least from eight to ten days, after the protein substance is introduced parenterally into the body. Such introduction may be through the intestinal mucosa by the absorption of undigested protein, by intravenous, intraperitoneal or subcutaneous injection, and probably also by absorption through any of the mucous membranes of the body. In experimental work, the intraperitoneal injection is probably the method of choice and was used in this work.

The degree of sensitization is affected in various ways by the initial or sensitizing dose. It has been demonstrated that small initial doses give rise to sensitization more quickly than large doses, although the ultimate degree of sensitization in both cases may be the same.[11] It has further been demonstrated that a primary dose sufficiently large to produce sensitization when injected alone, may totally fail to do so when injected together with or twenty-four hours after a large amount of some other protein.[12]

It is necessary that the second or shock dose be of the same type of protein as the sensitizing dose. In this regard the reaction is highly specific.[13] Wells says, "the anaphylaxis reaction exhibits exactly the same degree of specificity that we obtain with complement fixation or precipitin reaction." A guinea-pig sensitized to egg protein will exhibit anaphylaxis only on the subsequent injection of egg protein, one sensitized to horse serum requires horse serum for the production of shock, etc. This specificity is absolute for such widely different proteins as those cited, and the fact that group reactions are sometimes obtained when like proteins of closely related species are used need not be considered in the work herein reported.

---

11. Besredka: Anaphylaxis and Anti-anaphylaxis. English translation, 1919.
12. Lewis: J. Infect. Dis. **17**:241, 1915. (Quoted from Wells).
13. Wells, H. G.: Physiol. Rev. **1**:44. VonPirquet: Arch. Int. Med. **7**:259, 383 (Feb. March) 1911. Boughton, T. H.: J. Lab. & Clin. M. **5**:97 (June) 1920.

The route by which the second dose is introduced into the body is of great importance. According to Besredka and others, intravenous injection gives rise to the most delicate test. However, it has the disadvantage that it may give rise to false reactions because of embolism, blood coagulation, etc. The next most delicate test in the intact animal is induced by the intracerebral injection. Introduction of the shock dose by this route has been demonstrated by Besredka to be many times more delicate than the intraperitoneal or subcutaneous routes. The intracerebral injection is, therefore, the method of choice and was used in this work. The uterine strip method may also be used

Animals vary considerably in their apparent susceptibility to and in the symptomatology of anaphylactic shock. While the degree of susceptibility varies among different individuals of the same species, the symptomatology is fairly uniform for a given type of animal. Therefore, it is necessary, in comparative work, to use the same species of animal throughout. The most characteristic symptomatology is seen in guinea-pigs and thus these animals are used by the majority of observers in anaphylactic experiments.

The characteristics of anaphylactic shock as seen in the guinea-pig are outlined by Besredka as follows:

> Scarcely is the test injection terminated than the animal begins to struggle; it scratches its muzzle as if wanting to remove a foreign body. Its struggles become more and more marked; it commences to turn round and round and then to turn somersaults which become more and more frequent and violent. Then these convulsive attacks begin to take place at greater intervals, and the animal having become weakened from the output of so much energy, lies on its side. The vesicle and anal sphincters become relaxed; there is involuntary discharge of urine and feces. The respiratory movement, dyspneic at first, become slower and slower and finally become paralyzed, and at the end of an interval which varies from three to seven minutes, the animal dies of asphyxia.

This is, of course, the characteristic fatal shock. It does not necessarily follow that all tests must conform entirely to this description to be classed as anaphylaxis.

It will readily be seen from this brief exposition of the subject of anaphylaxis that it leads itself readily to the identification of the proteins in the breast milk. It was with this fact in mind that the following experiments were carried out.

PROTOCOLS OF EXPERIMENTS

Experiment 1.—Breast milk obtained from the mother of Case 1, after she had been eating no eggs for a period of ten days was injected into each of three guinea-pigs as a sensitizing dose. Two weeks later two of them were injected intraperitoneally with a solution of egg white and yolk. The third was injected with a few drops after the manner of Besredka.

Nothing unusual occurred in any case.

Experiment 2.—The mother was instructed to eat two eggs for breakfast on three successive days. Breast milk was obtained on each of these days at noon and a portion of each sample was injected into each of three pigs. A portion of the last sample was taken to Dr. Larson for preservation under pressure.[14]

Twelve days later two guinea-pigs were injected intraperitoneally with a mixture of egg white and yolk. The third guinea-pig was injected intrathecally with a few drops of the same mixture.

Aside from immediate signs of irritability nothing appeared in the guinea-pigs receiving intraperitoneal injections.

The third guinea-pig showed immediate nervousness, followed by spasmodic so-called bucking movement, shivering, chattering of teeth and partial paralysis of the hind legs. Gradual recovery inside of half an hour.

Experiment 3.—Three guinea-pigs were injected with 1 c.c. of a mixture of egg white and yolk. Twelve days later two guinea-pigs were injected intraperitoneally with 3 c,c. of the breast milk used in Experiment 2, which had been preserved by Dr. Larson. The third guinea-pig was injected intrathecally with a few drops of the same sample.

In the first two pigs nothing more definite than a severe dyspnea and marked nervous irritability were noted.

The third guinea-pig immediately fell over, kicking all four legs. Got up, hopping up and down. Extreme dyspnea was present. Fell over and got up repeatedly, each time with considerable difficulty. Definite paralysis of the hind legs noted twenty minutes after injection. Chattering of teeth, frequent defecation, marked dyspnea occurred together with the above symptoms for a period of one hour when the animal seemed to recover somewhat. Found dead seven hours after injection with body still warm.

Controls: This experiment was duplicated on three control guinea-pigs, none of which had been sensitized to egg protein. Nothing resulted.

Experiment 4 (Repetition of Experiment 3).—Mother was instructed to eat six eggs in one day—two at each meal. Milk obtained at 5 p. m. and before the 6 a. m. nursing the next day. Specimen mixed and given to Dr. Larson for preservation. At the same time two guinea-pigs were sensitized to egg white and yolk.

Twelve days later each guinea-pig was injected intrathecally with a few drops of the preserved milk.

The first guinea-pig showed immediate nervousness and dyspnea. In five minutes it fell over, kicking all four legs but rapidly got on its feet. Transitory paralysis of one hind leg. Defecated and urinated frequently. Recovery from most marked symptoms in fifteen minutes, but continued to be very irritable and to defecate frequently for a period of one hour. Normal in the morning and has been so since.

The second guinea-pig had immediate convulsion. Fell on side and kicked vigorously with head held in extreme retraction. Marked dyspnea. This continued without change for a period of twenty minutes. Then seemed to recover somewhat and got to feet very unsteadily. After this was up and down for a period of one hour at the end of which time there was still noted some paralysis of the hind legs. Five hours later there was still some paralysis of the hind legs but less marked. Perfectly normal in the morning and has been so since.

Control: A nonsensitized pig was injected intrathecally with the same amount of the same specimen of milk. Nothing unusual occurred.

CASE 2.—This case is of interest. A baby boy, aged 6 weeks, seen because of crying, especially at night, had frequent curdy stools and gaseous distension of the abdomen.

The baby is the second child of young and healthy parents. Breast fed entirely every four hours five times a day. He got along well for the first few

14. Larson et al.: J. Infect. Dis. **22**:271 (March) 1918.

weeks, gaining very rapidly. The mother had an abundance of breast milk, which seemed to be very rich from its appearance on standing. An analysis of a twenty-four hour sample of milk taken before, in the middle of and after feeding for the five feedings of one day, had shown 6½ per cent. fat.

The mother had already been advised to put the baby on an amount of breast milk which was about the optimum amount, figuring 100 calories to the kilogram. In spite of this, the colic and frequent stools had not cleared up, although the infant had gained about normally.

A few days prior to my seeing the baby a fine papular rash had begun to appear over the forehead, cheeks and scalp. This seemed to itch tremendously and the infant scratched incessantly. The lesion was typical of beginning eczema and having my previous experience fresh in mind I inquired into the diet of the mother. I ascertained that she was eating one egg daily.

Experiment 5.—Two guinea-pigs that had previously been sensitized to egg white and yolk were given intrathecal injections of a few drops of the fresh breast milk.

The first guinea-pig showed immediate irritability, extreme dyspnea, and convulsive hopping movements which continued for a period of thirty-five minutes. At the end of this time, 1 c.c. of the milk was injected intraperitoneally. The animal died within twenty-four hours.

The second guinea-pig immediately fell over in a convulsion. It lay on its side and kicked all legs vigorously, at the same time showing extreme dyspnea. This lasted twenty minutes. At the end of this time the animal recovered somewhat and tried to get on its feet, but it fell back. This continued for fifteen minutes more when the animal was injected intraperitoneally with 1 c.c. of the same breast milk. The animal died some time within the twelve hour period following.

Control: A nonsensitized guinea-pig was injected similarly with a few drops intrathecally, followed thirty-five minutes later by 1 c.c. intraperitoneally. Nothing unusual was noted in either case, and the guinea-pig was still alive at the end of eight days.

Experiment 6.—The mother was taken off eggs and two weeks later a guinea-pig which had been sensitized to egg white and yolk was injected intrathecally with a few drops of breast milk obtained fresh at that time. Nothing occurred.

CASE 3.—This was an infant showing, in addition to the signs of overfeeding, a papular, itchy eruption over the cheeks. The mother had been eating two to three eggs daily so that a sample of breast milk was obtained and the following experiment was conducted.

Experiment 7.—The sample of milk obtained, while the mother was on a diet containing two or three eggs daily, was given to Dr. Larson for preservation. At the same time, two guinea-pigs were sensitized to a solution of egg white and egg yolk. Two weeks later these guinea-pigs were injected intrathecally with a few drops of the preserved milk.

The first guinea-pig became immediately extremely irritable, hopping up and down, showing marked dyspnea and rubbing face with front paws. Frequent defecation. Recovery from the worst nervous signs in fifteen minutes, although continued to defecate frequently and to appear sick for a period of one hour. At the end of this time it was injected intraperitoneally with 1 c c. of the same solution. The guinea-pig died during the night.

The second guinea-pig showed immediate nervousness. Began moving round and round in circles. Marked dyspnea. Fell on side fifteen minutes after injection. Got up unsteadily. Five minutes later rolled over and over across the floor. Then got to feet, staggering markedly, especially in the hind quarters. These signs continued for a period of one hour when the animal was injected intraperitoneally with 1 c.c. of the same sample of milk. The pig died during that night.

Control: A nonsensitized pig was injected intrathecally with a few drops of the same sample of milk. A very transitory irritability was noticed. No hopping movement, paralysis of the hind legs or dyspnea. Normal inside of one minute.

Some minutes later the guinea-pig was injected intraperitoneally with 1 c.c. of the same milk. Still alive and well at the end of three days.

After these experiments were conducted, the baby was tested with the following foods that the mother had been eating as a regular part of her diet; lactalbumin, banana, beef, cocoa, corn, spinach, egg white, egg yolk, casein, wheat, potato, peach, salmon, orange, veal, carrots, rice, plum, oats, pork and peas.

Definitely positive reactions were obtained in the cases of wheat, beef, yolk, salmon, veal and carrots. Oats and peas were questionable.

DISCUSSION

A discussion of the experiments reported is hardly necessary any more than to call attention to the various points each experiment brings out. That there is nothing in the breast milk of a woman when she is not eating eggs, which is capable of reacting anaphylactically with egg protein, is shown in Experiments 1 and 6. In experiment 1 the breast milk was used as a sensitizing dose and in Experiment 6 it was used as a toxic dose. This was advisable because, as has been stated, if such protein substance were present in small quantity in the milk its sensitizing action might be masked by the relatively large amount of normal milk proteins present. Experiment 6 rules out this possibility.

Experiment 2 is very suggestive that after eating eggs, egg protein was present in the breast milk although it was not conclusive. Probably the reason why so slight a reaction was obtained in this case is because of the small amount of egg and large amount of milk protein present in the sensitizing injection.

Experiments 3, 4, 5 and 7 are proof that egg protein was present in the breast milk of three different women after they had taken eggs in their diet.

While it is not within the intended scope of this paper to discuss the clinical possibilities opened up by the work herein reported, a few points deserve mention at this time.

First, the mother in Case 2 was eating moderately of eggs, only one daily, and yet egg protein was present in demonstrable quantity in the breast milk. That the egg was causative in the disturbance of the child is shown by the subsequent history of the case. The mother was taken off eggs as a result of the experiment which has been reported. Two days later, the baby began to cry less and to sleep all night. The stools became of normal color and in a few days had lost their curdy nature almost entirely. One week later the infant was having one or two stools daily; there was almost no curd; they were normal in consistency and color; the child was sleeping all night and

crying very little during the day time, and the rash had disappeared from the face and forehead. This would have been classed as a case of over-feeding. When the infant did not improve on the reduction of food to the normal quantity for a child of its weight, we would have said the trouble was too much fat. Yet, when the offending protein was removed from the diet of the mother, the condition of the child cleared up without any reduction in the fat.

Only the protein of one food has been demonstrated to have come through the breast milk in these cases. However, it is very probable that other types do as well. This point is being investigated at the present time. The multiple sensitization of two of the infants in this series would suggest this very strongly since it is not probable that multiple sensitization would have been inherited when the mothers were not conscious of any ill effects from eating these foods. Furthermore, O'Keefe has shown that not one of the mothers in his series of ten cases gave positive tests to any of the proteins to which the infants were susceptible. This has also been true in several of my own cases not included in this series. It seems, then, that sensitization of the infants must have been actively attained and have come about only as a result of the ingestion of the foods contained in the breast milk.

A fact that has long been known, namely, that one infant will thrive on breast milk that another cannot tolerate, is easily explained on the grounds of the facts reported in this paper. Unless the second infant were also sensitized to the proteins contained in the milk we would expect nothing else.

CONCLUSIONS

1. It has been established that egg protein may be present in the breast milk after the ingestion of moderate quantity of egg at least by some nursing mothers.

2. It has been demonstrated as conclusively as possible under the conditions of the experiments that it may cause disturbance in the nursing infant under these conditions.

3. It is deemed probable that this may occur with almost any other food that the mother may eat.

4. It is contended that we must revise our ideas as regards the diet of the nursing mother and must study our cases of food disturbances in the nursing infant from the standpoint of what the mother is eating.

I am deeply indebted to Dr. W. P. Larson, Professor of Bacteriology of the University of Minnesota Medical School for many valuable suggestions throughout this work.

NUTRITIONAL KERATOMALACIA IN INFANTS

WITH A REPORT OF FOUR CASES

S. G. ROSS, M.D.
BALTIMORE

Keratomalacia, which has been defined by de Schweinitz as infantile ulceration of the cornea with xerosis of the conjunctiva, is synonymous with xerophthalmia, but as the most characteristic changes take place in the cornea, keratomalacia is possibly the term of choice. The four cases herewith recorded are published on account of the light which has recently been thrown on the etiology of a disease comparatively rare in this country. The first two cases were taken from the records of the Children's Department of the Johns Hopkins Hospital, and the last two cases were observed by me in the same clinic during the past year. They are the only cases which have occurred in more than 28,000 admissions to the clinic.

REPORT OF CASES

CASE 1.—M. W. G., female, white, aged 3½ months, was admitted June 29, 1917.

Diagnosis.—Acute gastro-intestinal indigestion; keratomalacia; sclerema.

History.—Family history negative. Full term, normal delivery. Weighed 12 (?) pounds at birth. Had "snuffles" at age of 3 weeks. Was breast fed for three weeks. Weaned at that age and fed on condensed milk. Apparently healthy until two weeks ago, when mother noticed child was becoming thin. However, she took her feedings well. June 18, vomiting and severe diarrhea commenced. Since then the child has been fed on barley water and occasionally egg-albumin water. The vomiting ceased after three or four days, but the diarrhea has continued, with the passage of greenish, slimy stools which contained no blood. She has suffered from a hacking cough throughout the illness, and for the past week has been somewhat stuporous and feverish. Three days before coming to the clinic both corneae were noticed to be dull in appearance.

Present Condition.—Temperature 104.4 F. Child in extremis. Face drawn, eyes sunken and barely open. The body and extremities show a purple tinge, and the subcutaneous tissues feel hard but pit on pressure. The child is semi-stuporous and reacts poorly to stimuli. Respirations are shallow and regular. There is a slight cough. The anterior fontanel is sunken. The anterior nares contain a dry exudate. The lips are dry. A normal percussion note is obtained over the lungs and the breath sounds are vesicular. Numerous fine râles are heard throughout the lungs, especially at the bases. There is a slight vaginal discharge. The body shows a generalized, hard edema of the scalp, and to a greater extent of the chest, abdomen and extremities. There is a slight scaling of the skin on the face and numerous petechiae are visible on the abdominal wall.

---

* Submitted for publication, May 5, 1921.

* From the Department of Pediatrics, Johns Hopkins University Medical School.

Eyes: Right, the bulbar conjunctiva is injected and the cornea is ulcerated and projects as a large staphyloma. Left, the bulbar conjunctiva is injected and the cornea shows several superficial ulcerations. Leukocytes, 20,700.

Treatment.—Stimulants. Diet: Protein milk.

Diary.—June 30: A case of extreme mehlnährschaden (Czerny) with sclerema and keratomalacia.

The patient died.

Necropsy Report.—Anatomic diagnosis: Keratomalacia; bronchopneumonia; follicular colitis; purpura.

CASE 2.—R. F., female, white, aged 6 months, was admitted July 11, 1919.

Diagnosis.—Acute primary pneumonia; acute intestinal indigestion; keratomalacia.

History.—Family history negative. Full term, normal delivery. Weighed 9 pounds at birth. Breast fed for two months. Was weaned and since then has been fed wholly on condensed milk. The child appeared to be healthy until five days ago when she began to vomit and had slight diarrhea. No blood or mucus in the stools. Has been drowsy since onset of illness.

Present Condition.—Temperature, 102.4 F. A fairly well developed but poorly nourished infant, lying in a comatose condition. Respirations are rapid and somewhat deep. She coughs occasionally and utters a weak cry on being disturbed. The extremities and lips show marked cyanosis. The anterior fontanel is widely open and slightly depressed. The right lung shows impaired percussion note in the axilla and over the entire posterior surface. The breath sounds over this area are diminished and at the right base they are tubular in quality. Fine moist râles are heard over this whole area. The heart sounds are faintly heard and the pulse is rapid and soft. Abdomen scaphoid. Some excoriation of the skin around the vulva and on the buttocks. There is a fine, red, papular eruption on the face, chest and extremities. The skin over the abdomen is waxy and inelastic. Eyes: Conjunctivae are markedly injected. The conjunctival sacs contain a considerable amount of purulent exudate. Both corneae show an ulcerated area in their lower halves. Leukocytes: 23,500. Pirquet negative. Urine contains a trace of albumin.

Treatment.—Diet: Protein milk.

Diary.—July 11, 1919: Refusing most of her feedings. Saline solution given intraperitoneally.

July 13: Doing badly. Stools, eight in twenty-four hours; green, watery, and containing mucus. No vomiting. Temperature, 105 F.

July 15: Definitely worse. Respirations extremely labored and somewhat irregular. Diarrhea severe. Refuses food. Pulse, 160; respirations, 64; temperature, 104 F.

July 16: Died.

Necropsy Report.—Anatomic diagnosis: Bronchopneumonia; keratomalacia; central necrosis of the liver.

CASE 3.—J. Y., male, white, aged 3 months, was admitted Oct. 5, 1920.

Diagnosis.—Acute gastro-intestinal indigestion; keratomalacia.

History.—The first six children in the family were breast fed and are alive and well. The last two (of whom the patient is one) were twins. They were born at term. Patient weighed 6 pounds and the twin 5½ pounds. Both were weakly. They were breast fed for three days, when the mother developed "inflammation" of the breasts and consequently the children were weaned and fed on condensed milk to which sugar had been added. They continued on this diet for three weeks and did well. On medical advice the food was changed to a cow's milk mixture. They both developed "summer complaint," with vomiting and diarrhea, almost immediately. The stools contained some blood and mucus. After four days, the mother stopped this diet and fed them again on condensed milk. She states that the babies improved and gained weight until about the age of 2 months, at which time the patient weighed 8 pounds. Four weeks ago both babies began to lose weight and strength. The

twin developed diarrhea and vomiting and died yesterday. The patient has had slight diarrhea and vomiting with loss of appetite. For the past week his eyes have been inflamed.

Present Condition.—Temperature, 100 F.; pulse, 120; respirations, 40; weight, 5 pounds, 10 ounces. A small, poorly developed, emaciated child. Appears very ill. Color is dusky. The anterior fontanel is markedly sunken. There is a purulent discharge from the nose. Lips dry. A few moist râles are heard at the base of both lungs behind. Abdomen is slightly distended. The head is retracted, and there is moderate rigidity of the posterior muscles of the neck. The skin is dry and shows slight desquamation. Eyes: Right eye, normal. Left, the conjunctiva is injected. The cornea is opaque and has a boiled appearance. At the medial sclerocorneal margin there is a round, punched out ulcer about 2 mm. in diameter. Leukocytes, 30,000. Urine shows a trace of albumin. Nasal culture: no Klebs-Löffler bacilli found. Wassermann, negative. Pirquet, negative. Roentgenogram of bones showed no evidence of rickets.

Treatment.—Diet: (Protein) milk.

Diary.—October 5, 1920: Intraperitoneal saline given.

October 6: Condition improved. Color better.

October 7: Marked abdominal distension.

October 8: Taking feedings better. Eyes show slight haziness of right cornea but no ulceration. The left corneal ulcer has perforated, with prolapse of the iris. Very slight inflammatory reaction. Remainder of cornea cloudy. Atropin, 2 per cent. 1 drop in each eye daily. Boric acid irrigations.

October 9: Cod liver oil, 5 minims, three times daily.

October 13.—General condition considerably better. Stools formed. No diarrhea.

October 15. No change in condition of the eyes. Considerable purulent discharge. No evidence of deep infection. Diluted cow's milk added to the feedings.

October 24: Discontinued cow's milk as it caused diarrhea. Added breast milk. During the past week the condition of the eyes has improved remarkably. The right cornea is clear. The ulcer on the left cornea is healed and shows only slight opacity. There is a synechia at the point of ulceration. No discharge from the eyes.

December 2: Discontinued protein milk. Mixed feedings of breast milk and diluted cow's milk with sugar added.

December 29: Discontinued breast milk. Given cow's milk and barley water with cane sugar added.

Jan. 12, 1921: Child is very good condition. Discharged. This child three weeks after admission began to gain weight gradually and on discharge weighed 8 pounds.

CASE 4.—A. G., female, white, aged 6 months, was admitted Oct. 8, 1920.

Diagnosis.—Acute gastro-intestinal indigestion; keratomalacia; furunculosis.

History.—Family history negative. Born at term. Fed on condensed milk from birth. Feeding very unsystematic. Child apparently did well. One month ago, diet was changed to diluted cow's milk with sugar. She was fed whenever she cried. Shortly after this she began to vomit and had slight diarrhea. There was no blood or mucus in the stools. October 4 the cow's milk was stopped and condensed milk again used. The diarrhea and vomiting stopped. Lately boils have developed.

Present Condition.—Temperature, 97 F.; pulse, 120; respirations, 36; weight, 6 pounds nine ounces. A poorly developed, emaciated infant, "little more than skin and bones." Very weak. Shows pallor and slight cyanosis. No hyperpnea. The anterior fontanel is slightly depressed. Lips are dry. There is moderate head retraction and the posterior neck muscles are hypertonic. Chest shows slight rachitic rosary. Abdomen scaphoid. Furuncles present over occiput, neck and shoulders. The child presents a wizened appearance and the skin is loose,

wrinkled and dry. Eyes: Right, the conjunctiva is injected. The cornea is cloudy and has a boiled appearance. On lower border of the cornea there is a rather superficial ulcer, oval and irregular, measuring 1 x 2 mm. Left eye, the conjunctiva is not injected. The lower half of the cornea has a faintly cloudy appearance. Leukocytes, 12,400. Wassermann, negative. Pirquet, negative.

Treatment.—Diet, (Protein) milk.

Diary.—October 8, 1920: Furuncles opened.

October 9: Cod liver oil, 5 minims, three times daily. Condition better.

October 17: Breast milk added to the diet. Stools normal. Furuncles healed. Weight, 7 pounds four ounces.

October 30: Eye lesions have healed. Only slight opacities remain.

November 3: Sudden loss of 9 ounces in weight. Child much worse. Slight vomiting.

November 4: Given saline intraperitoneally.

November 5: Condition bad. Child is cold, gasping for breath, pulseless; 5 per cent glucose solution given intravenously. Weight, 6 pounds 10 ounces.

November 6: Died.

No necropsy.

Etiology.—In a historical review of the subject Koun [1] gives Mackensie [2] the credit for having first noticed the relationship between this type of corneal disease and malnutrition in infants. Mackensie's description was as follows: "In particularly emaciated infants I have on many occasions seen the cornea of one or both eyes lose its substance, become prominent and perforate with almost no evidence of inflammation." During the following years the relationship of this malady to malnutrition in infants was fully confirmed. Etiologically, however, it was not clearly separated from the keratomalacia complicating certain acute infections, such as smallpox, measles, scarlet fever, malignant varicella, miliary tuberculosis, typhoid fever and meningitis. By certain writers it was considered a form of neuroparalytic keratitis. Others saw in it a manifestation of congenital syphilis. It was also noticed in the course of severe infantile diarrhea with malnutrition. With the advent of bacteriology, the flora of the eye were studied carefully in the hope of finding the causal agent, but in spite of the claims of many workers the weight of evidence seemed to be against the disease being due to any specific micro-organism. The bacteria appeared rather to play the rôle of secondary invaders.

Although the close connection between malnutrition and this condition had been established, it was not until the present century that the relationship between special dietary factors and this disease was studied carefully. Spicer,[3] however, had already made the observation that the condition occurred in England only among the artificially reared infants

1. Koun: De la kératomalacie, affection cornéene chez les enfants athrepsiques, Thèse de Bordeaux, 1903.

2. Mackensie: Traité pratique des maladies de l'oeil **2**:144, 1857. (Reference in paper of Koun[1]).

3. Spicer: Keratomalacia in Young Children, Lancet **2**:1387, 1892.

who had a diet lacking in nitrogenous elements. He also noted that it was not uncommonly seen in countries where the mothers of nursing children practiced long fasts. In 1904, Mori [4] described a disease occurring in Japan during the summer months, the symptoms of which were diarrhea, excessive appetite, swelling of the abdomen, loss of weight, night blindness, dryness of the skin and hair and xerosis conjunctivae. If more severe, there followed cloudiness of the cornea, keratomalacia, hypopyon, prolapse of the iris and finally blindness. The disease was most frequent in children of from 2 to 5 years. In a study of their diet, he found that breast feeding was almost universal for at least one year, and that following this, the diet consisted practically entirely of cereals and some vegetables. Cow's milk and fats were seldom used. He noted, incidentally, that rickets was almost unknown in Japan. During four years, Mori observed 1,511 cases of this disease of whom 116 developed keratomalacia. The treatment was eminently satisfactory. Cod liver oil acted as a specific. Other animal oils were useful and were found to be more satisfactory than vegetable oils. Mori considered that the disease resulted from a lack of fat in the diet. This fat deficiency was most marked in the summer. The diarrhea also prevented absorption of the fat taken in the food. He thought that the special value of cod liver oil might rest in its bile constituents. He also mentioned chicken liver and eel fat as popular remedies among the populace.

Czerny and Keller,[5] in their description of "Mehlnährschaden," a nutritional disturbance in infants resulting from a diet consisting almost exclusively of carbohydrates, pointed out that keratomalacia was one of the complications of this disease. They held the view that lack of fat in the food and possibly of protein was the dietary factor causing "Mehlnährschaden."

We must here review briefly some of the recent experimental work on this subject. McCollum and Davis [6] found that young rats failed to grow on a diet of pure casein, carbohydrates, and salt mixtures, sometimes even when part of the carbohydrate was replaced by lard. If the ether-soluble extract of certain substances like butter or eggs was

4. Mori: Ueber den sogenannten Hikan (xerosis conjunctiva infantum ev. keratomalacie) Jahrb. f. Kinderh. **59**:175, 1904.

5. Czerny und Keller: Des Kindes Ernährung, Ernährungstörungen und Ernährungstherapie, 1906.

6. McCollum and Davis: The Necessity of Certain Lipins in the Diet During Growth, J. Biol. Chem. **15**:167, 1913. McCollum and Davis; Essential Factors in the Diet During Growth, J. Biol. Chem. **23**:231, 1915. McCollum and Kennedy: The Dietary Factors Operating in the Production of Polyneuritis, J. Biol. Chem. **24**:491, 1916. McCollum and Simmonds: The Human Requirement for the Two Unidentified Dietary Factors for Maintenance Rather Than Growth, J. Biol. Chem. **32**:181, 1917.

added, growth became possible. This supported their belief that certain accessory food stuffs were essential for growth. Osborne and Mendel [7] reported that young rats which showed inability to complete their growth on a diet consisting of isolated proteins, starch, "protein-free milk" and commercial lard, had accompanying symptoms of diarrhea and diminished appetite. After three or four weeks, these animals developed inflamed eyes which soon showed a purulent exudate. These authors demonstrated the efficacy of cod liver oil, butter fat and egg yolk in restoring growth and healing the eye lesions. McCollum and Davis [6] concluded later that certain unidentified substances, aside from protein, carbohydrates, fats and salts, were indispensable for growth or prolonged maintenance, and that one class of such accessories was soluble in fats and another soluble in water. In 1916 McCollum [6] suggested the term "fat soluble A" factor for the accessory substance soluble in fats. In 1917, McCollum and Simmonds [6] advanced the hypothesis that lack of this factor caused a true "deficiency" disease characterized by stoppage of growth and xerophthalmia. The eye symptom was described as an edema of the eyes followed in time by blindness. These authors believed that the cases of human keratomalacia reported by Mori and Bloch should be regarded as a deficiency disease due to the lack of fat-soluble A.

Freise, Goldschmidt and Frank [8] following the lead of Hopkins, fed rats on a purified diet of casein, starch (extracted with alcohol), cane sugar, pork fat (heated to 140 degrees), and salts. With this diet, they were able to produce regularly in young rats stoppage of growth and keratomalacia. The symptoms developed in the following order: stoppage of growth, followed by loss of weight within about two weeks; in the third week loss of hair from the eyelids; in the third to fourth week retraction of the eyeball; and in the fifth to sixth week a visible corneal lesion with dryness of the cornea, which was quickly followed by cloudiness and ulceration without much inflammation. The condition was easily cured by the addition of a small amount of raw milk. They found no evidence that the disease was contagious. As opposed to general inanition being the cause, they noted that the eye symptoms began when only slight or no loss of weight had occurred. The authors concluded that certain "accessory food factors" of Hopkins were lacking in the diet and were the cause of this condition. They were evidently at the time

7. Osborne and Mendel: The Influence of Cod Liver and Some Other Fats on Growth, J. Biol. Chem. **17**:401, 1914.

8. Freise, Goldschmidt und Frank: Experimentelle Beiträge zur Atiologie der Keratomalazie, Monatschr. f. Kinderh. **13**:424, 1916.

unfamiliar with the work of McCollum. It was their opinion that clinically and histologically the disease was an experimental keratomalacia similar to human keratomalacia.

The most careful recent study of this condition in children has been made by Bloch[9] in Denmark. His first series of cases, numbering forty, was reported in 1916. Being at that time unaware of McCollum's work, he attributed the cause of the disease to the lack of some special substance, probably of the nature of lipoids, which was contained in certain fats. In a later series of twenty-three cases, Bloch, in the light of McCollum's work, took the view that these cases were due to a lack of the fat-soluble A factor. Of his cases, six showed the clinical picture of "Mehlnährschaden" due to a very one-sided carbohydrate diet. The other seventeen cases, however, were of a different type and did not suffer from the atrophy, edema and hypertonicity seen in the above mentioned disease. Neither had the latter group been overfed with carbohydrates. These patients, apart from the eye conditions, had slight retardation in development, poor appetite, anemia and their tissues were flabby. All cases, however, gave a history of faulty nourishment lacking in the fat-soluble A factor. If milk had been used, it was skimmed, centrifugalized, or buttermilk. Clinically, the author observed that the disease occurred most frequently in the months of greatest growth in an infant—from March to May. The cases occurring in children more than 1 year old were milder in type, and usually these children showed only a xerosis of the conjunctiva, whereas in infants under this age, the cornea was very prone to involvement.

Bloch had a very interesting series of eight cases of xerosis conjunctivae in a home for children in Copenhagen. A group of thirty-two healthy children, ranging from 1 to 4 years of age, were divided for nursing and feeding into two groups of sixteen each. In Group I, during May and June, eight cases of xerosis developed, while Group II remained free from the disease. The diets were similar, except that the children of Group I had been fed in the mornings an oatmeal porridge and rusks, while those of Group II were given beer-soup and some whole milk. This choice of diet for breakfast had been left to the nurses. Apart from the whole milk given to Group II children, the only fat supplied in the food of both groups was margarine from vegetable fats. Thus, unwittingly, a human experiment "en masse" was carried out, corresponding exactly to controlled feeding experiments in animals. The whole milk which Group II obtained had evidently protected these children from the disease. The treatment

9. Bloch: Klinische Untersuchungen uber Dystrophie und Xerophthalmie bei jungen Kindern, Jahrb. f. Kinderh. **89**:405, 1919.

was satisfactory, and consisted of cod liver oil without any change in the diet. Within one week the eyes were healed and the children all began to gain in weight.

The dietary history in our own cases is very clear cut. All four children had been fed almost exclusively on condensed milk, a food high in carbohydrate value and relatively very low in fat and protein. The probability is that we here have a food at least inadequate in the fat-soluble A factor although this assumption requires more statistical evidence, as well as experimental work in animals, to prove it.

Pathology.—In none of our cases was it possible to obtain histologic studies of the eyes. Dötsch [10] has given a description of the histology of the eye in two cases of keratomalacia in infants. In both cases, the conjunctival epithelium shows thickening of all the layers of cells. This was most marked near the corneal limbus. The cells of the superficial layer were flattened and their nuclei stained very poorly. In one case true cornification of the superficial layer had taken place. Moderate leukocytic infiltration of the epithelial layer and submucous tissue was present in one case. The cornea in both cases showed ulceration and microscopically these ulcers were seen to be filled with an exudate of pus cells, fibrin and necrotic material. Surrounding the ulcers, but in places slightly separated from their edge, was a dense leukocytic infiltration. The corneal epithelium, in contrast to the conjunctival, showed no increase in the depth of its cell layers. Indeed, near the ulcers it had disappeared.

Freise, Goldschmidt and Frank [8] studied the histology of the eyes in rats with keratomalacia. They found cornification of the superficial epithelial layer of the cornea. The middle layer of cells was swollen and stained poorly, while there was slight leucocytic infiltration of the deep layer. The corneal stroma was edematous, showed slight cellular infiltration, and newly formed blood vessels pushing their way from the limbus into the center of the cornea. No organisms were found in the cornea. They concluded that the histologic picture agreed with that which Dötsch found in human keratomalacia. Stephenson and Clark,[11] however, working with rats were unable prior to the bacterial invasion of the eyes to demonstrate any histologic change directly attributable to a dietary deficiency. In other words, the cornea appeared normal until the onset of the purulent inflammation. After this had appeared, the initial changes were swelling and edema of the cornea, accompanied by leukocytic infiltration. In a later stage, the corneal stroma showed an increase of the corneal corpuscles and

10. Dötsch: Anatomische und bakterologische Untersuchungen über infantile Xerosis, u. s. w., Arch. f. Ophth. **49**:405, 1900.

11. Stephenson and Clark: A Contribution to the Study of Keratomalacia Among Rats, Biochem. J. **14**:502, 1920.

the appearance of blood vessels. Finally, complete dissolution of the cornea resulted. Numerous micro-organisms were found in the inflamed eyes but none were specific. The authors concluded that "when a rat has been on a deficiency diet for such a length of time that the resistance of the cornea is affected, the pathogenic bacteria present in the conjunctival sac invade the corneal epithelium and induce the destruction of tissue."

In a histologic study of keratomalacia in rats, Wason [12] found changes similar to those already described. She noted both keratinization of the corneal epithelium and also an inflammation of the cornea and conjunctiva. She was impressed by the scarcity of organisms in the corneal and conjunctival tissues. It will thus be seen that the histologic findings in human keratomalacia have many points in common with what is found in the keratomalacia of rats. In the human type, Dötsch described keratinization of the conjunctival epithelium only. The corneal epithelium did not show this change which is present in the eyes of rats. The two processes are, however, of a similar nature. In both types, an inflammatory reaction is present which is remarkably slight in view of the severity of the lesions. Stephenson and Clark found no demonstrable degenerative changes previous to the infection in the eyes, and Wason's findings are in agreement with this. If their view be correct, the lesions are the result of a secondary infection due to a lowered resistance of the tissues, and thus correspond to bronchopneumonia and the other lesions which occur in this disease. McCollum and others have been unable to produce these eye lesions experimentally by the removal of any dietary factors, other than fat-soluble A and the lesion is always curable in rats by the addition of this substance to the diet unless death intervenes. Therefore, whether the original change in the eye lesion be degenerative or inflammatory in nature, it is probably due, primarily, to a specific lowering of the vitality of the cornea and conjunctiva as a result of the lack of this special factor in the diet.

Symptoms.—The usual history is that the infant has been artificially nourished. If milk has been used, it has been low in fat. Carbohydrates may have been given in excess. In older children on a mixed diet there has been a noticeable lack of animal fats. In our cases all the children had been fed exclusively for a long period on condensed milk. For a certain time the child may develop apparently in a normal manner, but finally the child ceases to gain in weight and loss of weight soon follows. The acute stage of the illness has now begun and, the younger the child, the more rapidly the disease progresses. There is soon evidence of severe malnutrition,

12. Wason: Ophthalmia Associated With a Dietary Deficiency in Fat-Soluble Vitamin A, J. A. M. A. **76**:908 (April 2) 1921.

especially if gastro-intestinal indigestion with diarrhea and vomiting develops, as occurred in all our cases. The skin becomes dry and scaly and loses its turgor. This, however, may be masked by the edema which is sometimes present, as in Case 1. The tissues are flabby. There may be hypertonicity of the muscles with retraction of the neck and stiffness of the limbs. Cases 3 and 4 showed this. These children are very prone to develop secondary infections at all stages of the illness, especially bronchitis and bronchopneumonia, rhinitis, pharyngitis, otitis media, pyelitis and furunculosis. Bronchopneumonia occurred and was the immediate cause of death in Cases 1 and 2, while in Case 4 there was furunculosis. The eye symptoms do not occur until the disease is well advanced, and in infants the lesion progresses rapidly. In older children photophobia may be the first symptom noted and night blindness may also be present early in the disease. The first change observed in the eye is a dryness of the conjunctiva with the loss of its natural glistening appearance. This may be followed by a wrinkling of the membrane and slight injection of the blood vessels. The cornea is next attacked. It becomes hazy, then opaque and finally ulcerates. These ulcers are usually situated in the lower half of the cornea. Perforation invariably follows unless the condition is treated, and is usually accompanied by hypopyon and prolapse of the iris. A purulent inflammation of the eyes generally develops as the disease progresses.

Prognosis.—The prognosis is grave in infants but improves greatly above the age of 1 year, as shown by the cases reported by Mori and Bloch. The older authors considered that the appearance of corneal ulceration practically signed the child's death warrant. The patient dies as a result of the nutritional disturbance and the eye lesion is an index that this is far advanced. Three of our four patients died; two of these had bronchopneumonia. It is of interest to note that in the other fatal case the eye lesions healed. In this case cod liver oil had been administered. The late appearance of keratomalacia, which is the only characteristic symptom of this disease, makes it rather difficult to recognize the condition at an early stage.

Treatment.—The chief indications in treatment are to supply the child with a sufficient quantity of animal fat which contains the fat-soluble A factor. Breast milk is the ideal food for infants. If not available, cow's milk should be used. In most of the cases the child's digestion is badly disturbed and great care is required in the feeding. The use of protein milk is advantageous when diarrhea is present. The use of cod liver oil should be begun immediately, beginning with small doses of 5 minims, three times daily, which may be increased as the digestive condition warrants it. The difficulties of feeding are well illustrated in Case 3 in which the child was unable to tolerate cow's milk for some time.

DISCUSSION

Nutritional keratomalacia of infancy is a specific manifestation of a dietary deficiency of the fat-soluble A substance. It is the only pathognomonic sign of the profound nutritional disturbance which results from a shortage of this factor, but it is accompanied by a number of variable signs and symptoms of disturbed metabolism. Different types of this symptom-complex are seen in the cases described by Bloch and Mori as well as in the cases described in this paper.

In what relation does this disease stand to "Mehlnährschaden"? The clinical picture of both may be identical, as seen in Cases 1, 3 and 4, and it must be borne in mind that although all children with "Mehlnährschaden" do not have keratomalacia, yet it is a frequent accompaniment of that disease. Czerny and Keller, in discussing the etiology of "Mehlnährschaden" considered that lack of fat in the diet was probably the principal cause. However, they recognized that the lack of protein and salts might play a secondary part. Finklestein and Meyer [13] thought that the lack of protein and salts was the chief factor. Salge,[14] from experimental work, decided that lack of fat was not the cause, but that lack of salts played the chief part. We must now recognize the fact that many children suffering from "Mehlnährschaden" have been nourished on a diet containing an insufficient amount of fat-soluble A. Moreover, it must be kept in mind that an amount of fat-soluble A which is sufficient to protect against keratoconjunctivitis may fall short of the amount required to promote optimal growth and nutrition. Therefore from the point of view of a fat-soluble A deficiency these two conditions may be related, but it must be remembered that the faulty diets fed to infants are not, as a rule, examples of a single but of multiple dietary deficiencies. Whether we are dealing with cases of "Mehlnährschaden" with keratomalacia or with the disease described above, other dietary faults beside a deficiency of fat-soluble A usually play a part in the production of the disease. Condensed milk diets, for example, are not only low in fat-soluble A but also in fat, protein and the antiscorbutic factor. The salt content of this food, in addition, is likely at fault. We must conclude that the characteristic eye lesion of "Mehlnährschaden" is due to the lack of fat-soluble A factor, although possibly other dietary factors enter into the production of this disease.

SUMMARY

To sum up, we have described a type of general nutritional disturbance which is accompanied by a keratomalacia which may be

13. Finklestein und Meyer: Lehrb. f. Kinderh. herausgegeben von Feer, 1914.
14. Salge: Ein Beitrag zur Pathologie des Mehlnährschaden der Sauglinge. Jahrb. f. Kinderh. **76**:125, 1912.

classified separately from the eye lesions occurring in certain infectious diseases and from other causes. This type of dietary malnutrition frequently corresponds closely with the condition first described by Czerny as "Mehlnährschaden." Clinically and histologically the keratomalacia is very similar to the eye lesions produced experimentally in rats by a diet lacking in the fat-soluble A factor. The weight of evidence would tend to show that the cases occurring in human beings have also resulted from a lack of the same factor. If so, this "nutritional keratomalacia" in infants is the manifestation of a definite "deficiency disease" in the sense in which we now understand the term.

The author wishes to acknowledge his thanks to Dr. Howland for permission to publish these cases and for many valuable suggestions in the work.

MEDULLARY MALIGNANCIES OF THE SUPRARENAL GLAND, WITH REPORT OF CASES *

WILLIAM E. CARTER, M.D.
SAN FRANCISCO

The subject of malignant tumors of the medulla of the suprarenal gland has received considerable attention during the last ten years. Since 1917, when Robert Hutchinson [1] first brought the subject to the attention of clinicians and pathologists, a number of cases have been reported; it seems extraordinary that the clinical condition was not discussed in detail before that time, particularly in view of the character and of the uniqueness of the metastases.

The suprarenal gland, composed of medulla and cortex, embryologically is derived from two separate layers. The cortex is mesoblastic; the medulla is neuro-ectodermic, which layer also gives origin to the sympathetic system of nerves. Tumors of the cortex produce a symptomatology quite different from that produced by tumors of the medulla. The cortical neoplasms produce the syndromes described by Bullock and Sequeira,[2] wherein there is premature sexual development, and by Guthrie and Emery [3] in which precocious obesity and muscular hypertrophy are features. Malignancies of the medulla occur only during childhood, and the symptomatology is entirely different. It is with such neoplasms only that this study is concerned.

Malignancies of the suprarenal medulla were recognized many years ago, although it remained for Hutchinson best to describe the clinical picture. They were usually designated as round cell sarcomas or as lymphosarcomas. Parker,[4] De Ruyter,[5] Orr,[6] Pepper,[7] Heaton,[8] and others have reported cases and described them as being sarcomatous. It is interesting to note that both Parker and Heaton thought that the suprarenal growth was secondary to the liver tumor. Rolleston [9] reviewed the various nomenclatures and concluded, "it is obvious that

* Received for publication, Jan. 2, 1921.

* From the Department of Pediatrics, University of California Medical School.

1. Hutchinson: Quart. J. Med. **1**:33, 1907.
2. Bullock and Sequeira: Tr. Path. Soc., Lond. **56**:189, 1905.
3. Guthrie and Emery: Tr. Clin. Soc., Lond. **40**:175, 1907.
4. Parker: Tr. Path. Soc. **31**:290, 1880.
5. De Ruyter: Arch. f. klin. chir. **40**:98, 1889.
6. Orr: Edinburgh M. J. **8**:221, 1900.
7. Pepper: Am. J. M. Sc. **121**:287, 1901.
8. Heaton: Tr. Path. Soc., Lond. **49**:140, 1898.
9. Rolleston: System of Medicine (Allbutt and Rolleston), Ed. 4 **1**:429, 1908.

these tumors" (primary malignancies of suprarenal medulla) "form a special group; it is probably most convenient to describe them simply as malignant hypernephromata."

Knowledge of the derivation of these malignant growths is of very recent date. Virchow [10] was the first to mention the possibility of the nerve tissue origin of such tumors, but his suggestion was nothing more than a conjecture. Dalton's [11] description of a tumor of the suprarenal medulla closely resembles the picture of what is now regarded as a neuroblastoma. Marchand [12] was the first to describe malignant tumors derived from fetal sympathetic ganglia. Kuster,[13] in 1905, reported a gliomatous neoplasm having a peculiar rosette appearance; but it was not until 1910 that Wright [14] used the term "neuroblastoma" and brought about a general acceptance of the belief in the neuroblastic origin of the growths. Since that time Pick,[15] Herxheimer,[16] Wahl,[17] Dunn [18] and others have firmly established the origin of these tumors. It has also been shown that a given specimen may contain cells both neuroblastomatous and glioneuromatous; and that a metastasis from a glioneuroma may be neuroblastomatous in type.

Clinically, the disease may be of the Pepper type, with striking liver metastases, or of the Hutchinson type, with secondary growths in the bones of the skull, sternum, vertebrae and long bones. In the class described by Pepper in 1901, there is a primary tumor, usually of the right suprarenal, with a large soft liver. At postmortem examination, the liver is found to be large, soft, mottled in appearance, and on section there is no localized evidence of metastases. Under the microscope, however, the lobules are seen to have disappeared and to have been replaced by small round cells. The neighboring lymph glands are affected, and, at times, the other abdominal viscera show secondary growths. There are no metastases to the bones of the skull. The disease runs a rapidly fatal course.

In Hutchinson's type, the metastases are entirely different. Very often, the first sign that attracts the attention of the mother is an ecchymotic spot round one eye, which she usually attributes to a fall. The child exhibits malaise, anorexia, restlessness and loss of weight. Oftentimes, palpation of the lumbar region fails to show any tume-

---

10. Virchow: Die Krankhaften Geschwülste **2**:149, 1864.
11. Dalton: Tr. Path. Soc., Lond. **36**:247, 1885.
12. Marchand: Festschr. f. R. Virchow; Intern. Beitr. z. Wissench. Med., Berlin **1**:578, 1891.
13. Kuster: Virch. Arch. f. path. Anat. **180**:117, 1905.
14. Wright: J. Exper. M. **12**:256, 1910.
15. Pick: Berl. klin. Wchnschr. **49**:16, 1912.
16. Herxheimer: Beitr. z. path. Anat. u. z. allg. Path. **57**:112, 1913.
17. Wahl: J. M. Res. **30**:205, 1914.
18. Dunn: J. Path. & Bacteriol. **19**:456, 1915.

faction. Several cases are reported by very competent observers in which no tumor could be made out although its presence had been strongly suspected, until some time after the revealing orbital hemorrhage had occurred. The proptosis, so bizarre and so constant in the majority of reported cases, should put the physician on his guard (Figs. 1, 4, 5 and 11).

There are only two conditions in which confusion is likely—chloroma and scurvy. Both may be ruled out easily; the former, by the green appearance of the growth and by a blood smear showing a lymphocytosis; the latter, by the presence elsewhere of scorbutic signs, such as epiphyseal tenderness (from subperiosteal hemorrhage) and bluish gums.

Occasionally, metastases occur in the other bones, particularly the sternum, ribs, long bones of the extremities and, in one reported case, in a vertebra. Such metastases produce less evident symptoms than do secondary growths in the skull bones; no doubt they are frequently overlooked even at necropsy.

There has been little added to Hutchinson's original clinical contribution. His information of the character of the neoplasms and of their method of metastasizing, however, was incomplete, and other observers since have been able to review the reported cases with clearer conceptions.

Frew [19] described three cases of his own, and was able to collect forty-eight cases from the literature. While the records of the reported cases are incomplete, he believes, from a study of the reports and from observation of his own cases, that "the disease gives rise to two entirely different clinical syndromes . . . . . depending on which suprarenal is involved." He divides them into two classes: (*a*) when the principal growth is in the left suprarenal medulla, and (*b*) when the principal growth is in the right suprarenal medulla.

In the first class he places twenty-two of the fifty-one cases; in the second class, twenty-nine cases are included. All these cases, except four, showed cranial metastases. One patient had a secondary growth to the vertebrae, and three patients showed no bone lesions at all. Six patients complained of leg pains (probably due to pressure on the lumbar plexus). Fourteen had exophthalmus; eleven of these showed a right sided proptosis. Secondary anemia and optic neuritis were fairly constant. In none of these fifty-one cases was there premature sexual development.

In the second group, the metastases to the orbits were always first on the right side. A small mass of glands was usually palpable behind

19. Frew: Quart. J. Med. **4**:123, 1910.

the right clavicle. The tumor mass was larger than in the cases in which it occurred on the left side, and metastases to the neighboring organs were commoner.

In the matter of the method of metastasis, Frew advances the theory that the cells are carried by the lymph stream. He supports this contention by consideration of the anatomy of the lymph spaces and of the symptomatology and postmortem findings when either the right or the left suprarenal is involved. He calls attention to the fact that on the left side the lymphatics pass out of the suprarenal gland with the suprarenal vein, join the lymphatics of the left renal vein and connect with the lumbar nodes and aortic lymphatics. Some of them pass downward into the groin, and others pass upward, forming a chain of glands around the aorta, to the deep anterior cervical chain and thence into the skull. The lymphatics of the right suprarenal gland run into the thoracic duct directly without communication with the lumbar glands. In all his collected cases of right sided suprarenal tumor, the metastases to the orbits occurred first on the right side. The distribution of the metastases indicates to Frew that the dissemination of the growth occurs through the lymph channels either forward with the lymph stream or in a retrogressive fashion, and not by way of the blood stream.

It is an unusual circumstance that three of these cases have been encountered within four months in the department of pediatrics of the University of California Medical school. It is regrettable that in only one of these cases was a complete anatomic and histologic study possible.

In the first case, however, operation gave us opportunity to study the specimen. In the second case, a full report of which is appended, a complete examination was permitted. The third report, which comprehends only the clinical aspects of the case, is of some interest because it details metastases to the skin of the leg and to the scalp. These secondary invasions of the skin must be exceedingly uncommon as a close search of the literature reveals but one other similar case, (Richards[20]; Figs. 12 and 13). In all three of these patients, the orbital hemorrhage (Figs. 1, 3, 4, 5, 10 and 11) was the revealing sign.

On consideration of the increasing number of reports of malignancies of the suprarenal medulla with secondary growths to the orbit, it would seem probable that former ideas of the incidence of malignant tumors which occur during childhood, would be in error. The table given by D'Espine and Picot,[21] which included an analysis of 754

20. Richards: Guy's Hosp. Rep. **59**:217, 1905.
21. D'Espine and Picot: Traité des Maladies de L'Enfance, 1899, p. 318.

cases, wherein 138, or 18 per cent., occurred in the orbit, seemingly would bear further consideration. It is not improbable that many of these cases were unrecognized suprarenal medullary malignancies with metastases to the orbits, and that they were regarded as primary growths in the orbits themselves.

REPORT OF CASES

CASE 1.—L. C., female, aged 17 months, Russian descent, entered the University of California Hospital, Feb. 25, 1920. Complaint: Loss of weight; loss of appetite; swelling of the left eye and of the entire left side of the body, particularly the foot and ankle.

Family History.—Father and mother living and well. One brother, 7 years old, is well. The mother has had no miscarriages, and there is no history of tuberculosis or syphilis.

Past History.—The infant was full term, normal delivery. Its birth weight was 7 pounds. It was breast fed for fifteen months and was then put on a mixed diet. The first tooth appeared at 7 months. The child sat up at 7 months and walked at 14 months. It has had no illness except a mild infection of the external ear.

Fig. 1.—L. C. Bulging of the left eye and edema of the left side of the face.

Present Illness.—The child seemed well until about two months ago when its appetite failed and it became irritable. At about this time the mother noticed a blue spot under the left eye which she attributed to a fall. This area increased rapidly, until within a week the whole orbital region was involved.

Physical Examination.—The child cries incessantly. When laid on its back, it immediately rolls over on its left side. The entire left side is edematous. This is especially marked in the lower leg and foot. The hair is thin and poorly nourished; the head is well shaped. The fontanels are closed. The skin is elastic and the tissue turgor is good. The ears and nose are negative. There are no palpable glands in neck region, axillae or groins. The throat is negative.

The left eye (Fig. 1) shows a marked bulging with ecchymosis particularly conspicuous in the infraorbital region. The pupil reacts to light. There is a complete atrophy of the nerve head.

The right eye is normal in appearance, it reacts to light, the vision is apparently unimpaired and its fundus is unchanged.

The heart and lungs are normal. The abdomen is protuberant and on palpation, a hard, slightly movable mass can be determined filling the left side of the abdomen and extending 4 cm. to the right of the median line. Other than the edema of the left arm and leg, the extremities appear normal. There are no pathologic reflexes present.

The urine shows a trace of albumin; it is negative for sugar. The sediment shows no casts, but contains numerous pus cells.

The von Pirquet test is negative, also the Wassermann.

Blood Examination.—Hemoglobin, 30 per cent. (Sahli); erythrocytes, 2,800,000; leukocytes, 27,500. Differential count: Polymorphonuclears, 71 per cent.; small lymphocytes, 18 per cent.; large lymphocytes and transitionals, 11 per cent.

Clinical Course.—While in the hospital the child failed markedly. It cried incessantly, slept little and refused all food. The temperature ranged from normal to 38 C. until the seventh day in the hospital when there was a fever. This was followed by an increase in the amount of pus in the urine. Exploratory incision with drainage was recommended as a palliative. At operation, the surgeon found a fluctuant left kidney with a hard mass about the size of a small orange just above it. Both were removed (Fig. 2). Enlarged glands could be felt around the ureteral stump.

Fig. 2.—L. C. Shows large left kidney with roughened capsule. Suprarenal adherent to upper pole.

On section the kidney showed a dilated pelvis with pus covered walls. The cortex was thinned but contained no secondary growths. The capsule stripped readily. The upper pole of the kidney was flattened and adherent to the mass above it. Near the ureteral opening of the pelvis could be seen several nodules ranging in size from ¼ to 1 cm. in diameter and partially blocking the ureter.

The tumor mass itself was pear-shaped, about 6 cm. at its greatest diameter and adherent to the upper pole of the kidney. It was firm to the touch and was covered with a glistening capsule. It cut without difficulty. The cut surface was grayish in color, but there were several darkened hemorrhagic areas throughout. The pathologist's report of the microscopic sections was: neuroblastoma of the suprarenal medulla.

Case 2.—J. D., male, age 21 months, Spanish descent, entered my service at the San Francisco Hospital, June 14, 1920, with an admission diagnosis of possible skull fracture.

Family History.—The patient is the thirteenth child. Three pairs of these children were twins. Seven children are living and well. Six are dead of unknown causes. Father and mother are living and well.

Past History.—The child was full term, normal delivery. It was fed at the breast until 1 year of age. Since that time a mixed diet has been given, probably of fair quality as the family has been under the care of a social organization. The infant sat up at 5 months; walked at 11 months; began to talk at 1 year; had four teeth at 1 year. There is no history of any acute infectious disease.

Present Illness.—Two weeks ago the patient fell downstairs. He cried a little and the mother put him to bed. He slept well all night. The next morning the mother noticed a dark spot over the left eye. On close inquiry, a history of listlessness and anorexia was elicited, which condition had extended over a period of about a week before the fall. The interpreter, an older child, volunteered the information that the baby had been quite irritable and cried when it was handled. Following the fall, the mother had observed a slight protrusion of the left eyeball which had become progressively greater until it was impossible for the child entirely to close the eye.

Physical Examination.—The patient is a poorly nourished, fairly well developed boy. The fontanels are closed. The head is well shaped although there

Fig. 3.—J. D. Shows bulging of the left eye and flaring of the lower rib cage particularly on the left. This is a left sided tumor. Picture taken June 15, 1920.

is slight frontal bossing. The hair is luxuriant. The skin is elastic and without blemish. The tissue turgor is fair. Outside of a slight flaring of the ribs, more marked on the left side (Fig. 3), the chest is well formed. The abdomen is protuberant. The extremities are well formed; they are slightly emaciated and there is a mild edema of both ankles and feet. The external ears are negative and the drums are normal in appearance. There is a mucus nasal discharge. The teeth, sixteen in number, are well formed and without cavitation. The tonsils are slightly enlarged but they are not reddened and there is no exudate.

The left eye (Fig. 4) shows a yellowish discoloration of the upper lid and an ecchymotic spot about 1 cm. in diameter above the external canthus. Proptosis is marked. The pupil is dilated and there is no reaction to light. The fundus shows a fullness and a blurring of the nasal margin. The temporal margin is clearly outlined.

On the right eye there appears a faint bluish area about ½ cm. in diameter in the midinfra-orbital region. There is an evident fullness of the entire

orbital region, but no bulging such as appears over the left orbit. The pupil is dilated and does not react to light. The fundus shows a faint blurring of the end of the nasal margin; otherwise it is negative.

The anterior and posterior cervical glands are not palpable. The axillary and inguinal glands can be just palpated. The heart sounds are normal. The lungs are negative.

On palpation of the abdomen, a large mass can be determined filling the upper left quadrant and extending into the left pelvis. There is a marked fullness in the left costovertebral angle. The abdominal mass extends into the right abdomen beyond the right border of the rectus and to within 4 or 5 cm. of the right iliac crest. The line of demarcation between the tumefaction and the liver cannot be determined.

The genitals are negative other than a slight phimosis. The knee jerks are normal; Babinski and Oppenheim are negative, and there is no ankle clonus. The abdominal reflexes are sluggish; the cremasteric is present.

A catheterized specimen is clear, neutral in reaction and negative for albumin and sugar. Acetone is present. The sediment shows occasional epithelial cells, one granular cast, and occasionally white blood cells.

Blood Examination.—Hemoglobin, 70 per cent (Dare); erythrocytes, 4,600,000; leukocytes, 15,700. Differential count: Polymorphonuclears, 62 per cent.; small lymphocytes, 36 per cent.; large lymphocytes and transitionals, 2 per cent.

The von Pirquet and Wassermann tests were negative.

Fig. 4.—J. D. Shows bulging of the left eye and ecchymotic spot on the right infra-orbital region. Picture taken June 15, 1920.

Clinical Course.—The patient has been in the hospital 8 days. During this time the temperature has ranged from normal to 100 F. The child has been fretful and restless. It has failed visibly. The protrusion of the left eye has increased rapidly and the right eye has begun to bulge. The abdominal mass shows no change.

The parents took the child home against advice but two weeks later they were induced to take it to the Children's Hospital. During this stay at home, the emaciation increased, the protrusion of the right eye became more marked, and the left eyeball ruptured (Fig. 5). There has appeared in the left temporosphenoidal region an area of tumefaction about 6 cm. in diameter. It is rather firm to touch, and its margins fade off into the surrounding tissue. A similar area is palpable on the right temporosphenoidal region, but it is not so large. The abdominal mass is visibly increasing in size. The child has been comatose since entry. Today, three days since hospital re-entry, it died.

Postmortem Examination.—The body is that of a very emaciated male child of about 2 years. The hair is luxuriant and dark and well nourished. The skin is a lemon tinge. There are no blemishes or ecchymotic spots. The left eyeball is markedly protuberant and is ruptured. The right is less protuberant The margins of the conjunctivae cannot be approximated. There are masses

over both temporal regions; the left is larger than the right. They are rather hard on palpation. The left measures about 7 cm. in diameter; the right 4 cm. The rib outlines are easily visible. There is a flaring of the lower chest cage and the abdomen is protuberant. The arms and legs are very emaciated but not edematous.

On opening the chest cage and abdomen, a distended stomach is noted. The lesser curvature contains a hemorrhagic area 1 cm. in diameter. The omentum is adherent to the transverse colon and to a large mass in the left abdomen. The anterior mediastinum contains no glands. The pericardium contains 2 or 3 c.c. of clear fluid. The heart is anemic appearing and rather soft, but it is otheriwse negative.

Lung: The left lung is slightly adherent at the apex. There is a slight pleural exudate which has begun to organize. On section the lower lobe shows slight induration but it contains air. The apical pleura is roughened.

The right lung contains a few small scars near the root. The lung substance is pale throughout and crepitates readily. There are no adhesions to the diaphragmatic pleura on either side.

Fig. 5.—J. D. Shows rupture of the left eyeball, bulging of the right eye and extreme tumefaction over both temperosphenoidal regions. Picture taken July 6, 1920, three weeks after Figures 3 and 4.

Abdomen: The abdomen is filled with a large mass, which presses the diaphragm upward. The coils of intestine are adherent to each other, to the colon and to the fundic end of the stomach. A mass fills the entire left abdomen and two-thirds of the right. Coils of intestine and omentum are strongly adherent to it.

Spleen: The spleen is pushed forward by the mass to which it is adherent but it is normal in size.

Bladder: The bladder is negative.

Liver: The liver is not enlarged. It is soft, slightly mottled over its diaphragmatic surface and the under surface is adherent to the tumor mass. The gallbladder appears to be negative. On section, the liver shows a nodule 1½ cm. in diameter situated at about the center of the upper surface of the right lobe. The lobules appear normal in color and consistency.

Kidneys: The right kidney is adherent to the mass which has extended entirely across the abdomen. The kidney is pale, soft and normal in size. The capsule strips easily. The cortex is rather thin and pale. There are no metastatic growths. The right adrenal is normal.

The left kidney is buried in the tumor mass. On dissecting it loose from the tumor it appears to be flattened at the upper pole. The capsule strips readily. On section, there is a small dark area, just under the capsule in the upper pole. It appears to be hemorrhagic. The surface of the kidney is covered with small, white, raised nodules from 3 to 4 mm. in diameter. They are just under the capsule but not adherent to it.

Pancreas: The pancreas is included in the mass. On dissecting it out, it appears soft, friable and hemorrhagic. It contains no metastatic areas on section.

Fig. 6.—J. D. Left kidney and suprarenal gland. Kidney almost buried in the mass; sectioned transversely. Tumor sectioned perpendicularly.

Tumor: The tumor (Fig. 6) is about 15 cm. in diameter. It is encapsulated. It lies just above the left kidney. On section, it is grayish-yellow in color and contains dark hemorrhagic spots which have not liquefied. It is soft and cuts without difficulty. Its weight is 570 gm.

Lymph Nodes: The mesenteric glands are enlarged, ½ to 1 cm. in diameter. They are soft. The portal lymph glands are slightly enlarged. Small lymph glands extend down the margin of the mesentery but do not follow the iliac arteries into the groins. The chains extend upward along the aorta into the neck. Glands are not palpable in the superficial cervical area.

Intestines: The intestine are negative.

Thymus: The thymus is not enlarged.

Head: The calvarium is firmly adherent. There are metastases over the anterior four-fifths of the parietal and frontal lobes. The secondary growths extend backward over the under surface of the parietal and occipital bones to the internal occipital protuberance. The bone metastases are extra-dural, hemorrhagic, soft, non-encapsulated, diffuse and moth-eaten in appearance. They extend forward into the great mass over the temporo-sphenoidal area. The dura (Figs. 7 and 8) is not adherent to the brain cortex. The under surface of the dura is smooth, except at four small areas along the falx, where

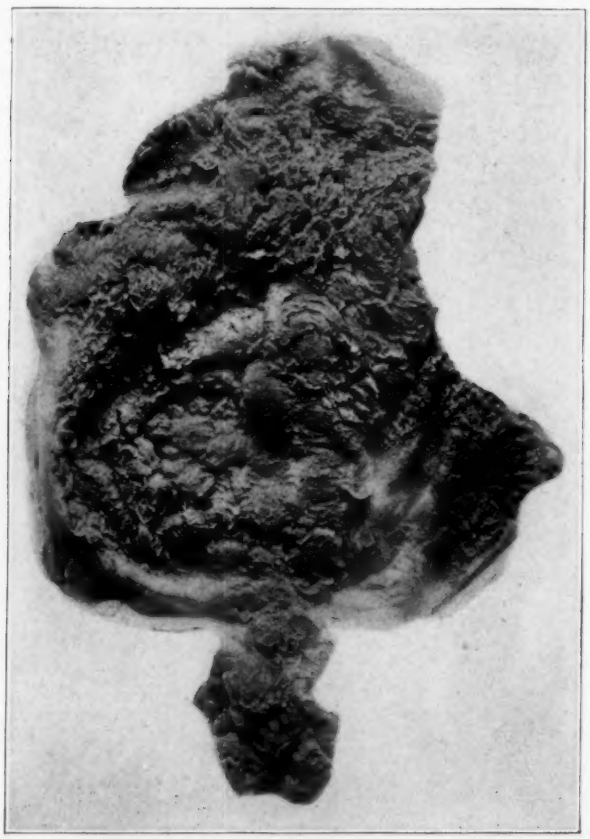

Fig. 7.—J. D. Superior surface of the dura which was firmly adherent to the calvarium. The lower table of the skull is similarly involved.

the secondary growths are in the form of reddened areas, from ½ to 1 cm. in diameter. At these points there are beginning adhesions. There are marked metastatic growths in the floor of both anterior fossae. In the left fossa, there are two bluish areas, lying side by side, from 2 to 3 cm. in diameter. In the right fossa, a similar tumefaction may be seen. The fossal growths are connected by a commissure. The body of the sphenoid (Fig. 9) has the same appearance as the under side of the calvarium.

There seem to be no metastases (on palpation) in the vertebrae, ribs or long bones.

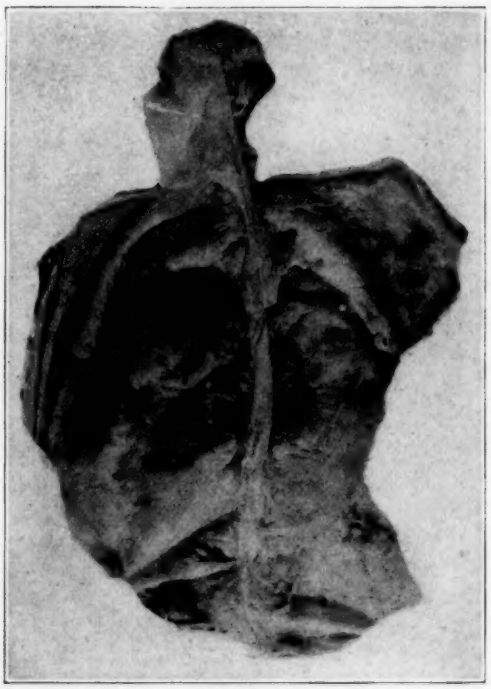

Fig. 8.—J. D. Inferior surface of the dura. Note growth coming through in two or three places.

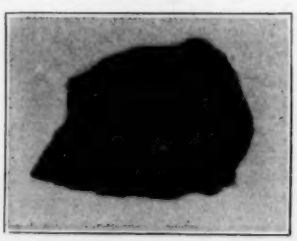

Fig. 9.—J. D. Body of the sphenoid bone chiseled out. Same appearance as that of the upper surface of the dura and the inner table of the skull.

Diagnosis: Microscopic examination of the sections indicates a neuroblastomatous tumor of the suprarenal medulla with a like histologic picture in the metastases.

CASE 3.—C. B., female, aged 5 months, Italian descent, was seen in her home, July 17, 1920. Complaint: Loss of appetite, loss in weight and lumps in the skin.

Family History.—The father and mother are living and well. There is one older sister, 2½ years of age, in good health; no other children, living or dead, and there is no history of miscarriages. Syphilis is denied.

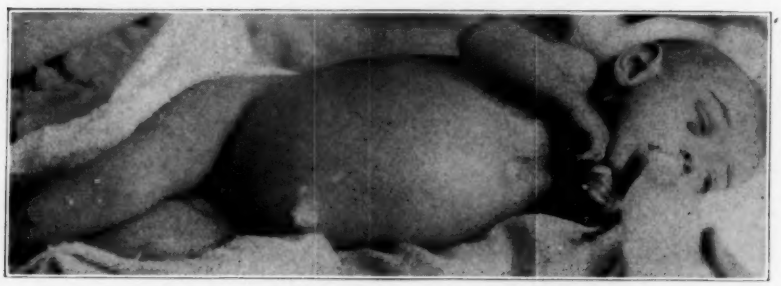

Fig. 10.—C. B. Shows distended abdomen and metastatic nodule on right leg.

Fig. 11.—C. B. Shows ecchymosis under right eye and nodule in scalp.

Past History.—The child was born at term; the delivery was normal. The infant was breast fed for two months at which time the mother, thinking herself pregnant, put the baby on artificial food. The feedings were of various kinds and included several proprietary foods. The child never prospered. It has cried a great deal and has always looked pale. There is no history of any infectious disease.

Present Illness.—When the child was 3½ months old, the mother noticed a small lump on its scalp just above the hair line of the forehead. At about the same time she observed a dark bluish spot about the size of a dime on

the anterior surface of the right tibia. Several days later another darkened spot appeared on the child's chin. A physician was then called who removed some blood for a blood test. The next day (about June 15, 1920) the mother noticed a dark spot under the left eye and a small lump in the right axilla.

Physical Examination.—The patient is an ill nourished girl who cries incessantly. The hair is profuse. The head is well shaped and there is no bossing. The posterior fontanel is closed. The anterior fontanel measures 2 by 3 cm. The ears are normal. The throat is slightly reddened. There is a dark ecchymotic spot 1 by 2 cm. in size under the right eye (Figs. 10 and 11). The upper lid

Fig. 12.—C. B. Shows metastatic nodule in right frontal region.

Fig. 13.—C. B. Shows metastatic nodule over the right tibia.

also shows slight discoloration. The left eye is negative. Both fundi appear normal. The nose is negative. Glands are nowhere palpable, except for a small nodule in the right axilla. As there is considerable emaciation, the ribs stand out prominently and there is a marked and equal flaring of the lower end of the cage. On the tenth rib, right side, scapular line, appears a tumefaction about 3 cm. long. The heart and lungs are normal. The abdomen is distended (Fig. 10) and there is a palpable mass, rather firm, best felt over the right lumbar region and extending forward to the mammary line. The liver is not enlarged; the spleen is not palpable. The reflexes are normal. There is no edema. The skin is soft but dry. At the lower, anterior third of the

right tibia (Figs. 10 and 13) appears a nodular mass, about 1 cm. in diameter. It is not attached to the bone. On the right frontal region is a like nodule (Fig. 12), also nonadherent to the bone. A third similar mass can be palpated just under the point of the chin. The tumor in the right axilla appears to be glandular.

The Wassermann test was negative.

Blood Examination.—Hemoglobin, 70 per cent.; erythrocytes, 3,400,000; leukocytes, 13,400. Differential count: polymorphonuclears, 48 per cent.; small mononuclears, 43 per cent.; large mononuclears, 9 per cent. Three normoblasts are seen. Blood platelets were not estimated but they were greatly increased.

The child died July 20, 1920. A postmortem examination was not obtainable.

SUMMARY

1. Suprarenal medullary malignancy is not an unusal occurrence.

2. In the majority of cases an orbital hemorrhage is the first sign observed, and it may occur before any tumor is palpable.

3. The orbit first involved is often on the same side as the primary tumor.

4. Diagnosis is not difficult once the orbital hemorrhage has occurred; the disease is likely to be mistaken only for trauma, chloroma and scurvy.

5. Surgical interference can be of no avail, except as a palliative to drain a pyonephrosis or to meet other complications, as the metastases usually occur before a diagnosis can be made.

6. Metastases probably occur via the lymph stream.

7. The malignancy rarely may metastasize to the skin.

8. The medulla of the suprarenal gland being neuro-ectodermic in origin, these malignant tumors are similar in their histologic structure to malignant neoplasms of the sympathetic nervous system and they are correctly designated as neuroblastoma.

I am indebted to Dr. Langley Porter and to Dr. William P. Lucas for the reference of two of the cases.

SIZE AND WEIGHT IN ONE HUNDRED AND THIRTY-SIX BOARDING SCHOOL BOYS (GROTON) *

H. GRAY, M.D. AND W. J. JACOMB
BOSTON, MASS. GROTON, MASS.

PART I

How Many Children are Unfit.—The necessity for further study of this seemingly hackneyed topic is clear from the statement of Emerson [1] that his extended studies have shown that at least one-third of the children in this country are sufficiently underweight for their height to require treatment for malnutrition. In another place, also in 1919, he re-affirmed that from 20 to 40 per cent. of those graduating from elementary schools are physically unfit. By way of definition of the unfit, he urged that "all children habitually 7 per cent. or more underweight for their height are not only undernourished but malnourished, retarded in both weight and height from one to four years."

L. B. Gloyne (1920) has reported similar disquieting findings in school children.

It occurred to us to compare the weights (and also the height and chest-girth) of a series of private school boys with the usual standards. In brief, our findings were that the boys' weights as provided by these standards averaged more than 7 per cent. above their weights as actually observed.

Hence, either one of two things may be true: (1) These children of good American parentage, liberal feeding, expensive education, extensive outdoor life, and careful medical supervision, were none the less abnormal, or in Emerson's words, "physically unfit"; or (2) the current standards are "unfit" for judging this "cultured type" of boy.

Lack of a Standard Suitable for Private School Boys.—That the latter is the case is indicated by the large number of current standards. Indeed, their number and divergent nature indicates that no one of them has won general approval, even for judging boyhood in general in American public schools.

The purpose of this paper is to compare certain of these standards with the actual observations on 136 healthy private school boys in order to determine which of these standards is the most suitable for use in connection with this particular class.

---

* Received for publication April 11, 1921.

1. Emerson, W. R. P.: Boston M. & S. J. **181**:139 (July 31) 1919; International Clin., Series 29, **4**:212, 1919; Am. J. Dis. Child. **17**:251 (March) 1919.

For one thing, it seems worth while to differentiate the normal from the ideal. The usual standards of normal have been compiled by making observations on public school boys of widely differing heritage. In other words, the subjects studied have been in many cases children who have not had the advantages of the best environment and nourishment, and who also come from parents of short stature.

It has been pointed out by Friedenthal (1914), and Holt,[2] (1918) and particularly exhaustively by Benedict and Talbot,[3] (1921) in their report to the Carnegie Institution, that the usual standards mentioned above are not suitable for children who spring from at least several generations of American stock, which is admittedly taller than that of many foreign nations, to which belong the parents of many of our public school boys; children who, besides, have been nurtured in as nearly an ideal manner as possible today.

It seems justifiable, therefore, when one is desirous of estimating the normality of a boy in a boarding school or in a country day school, to use as a standard figures compiled from similar boys, instead of the usual figures compiled from the variegated population of a public school. Such a standard may be called an ideal standard to differentiate it from the usual normal. Such standards are presented herewith in brief, and will be more fully presented elsewhere.

MATERIAL

The subjects studied were 136 boys at Groton School, Groton, Mass., a private boarding school in the country, about two miles from the nearest town. Boys who were not perfectly normal on physical examination were not included in this study. This sifting and exclusion of the subnormal is essential, since Emerson, in 1917, in a vital group study of the results of one-hundred physical and mental examinations of so-called well children, aged from 5 to 15 years, demonstrated that 98 per cent. of these children had from one to eleven abnormal conditions, with a total of 472 conditions actually needing treatment. Recently, he has enlarged his series to 602 children with much the same extraordinary results.

The subjects here reported on seemed to be not only physically unexceptionable, but were also carefully protected from the most frequent factors enumerated by Emerson[1] (1919) as causing malnutrition, namely: (1) Physical defects, such as adenoids and abnormal tonsils and carious teeth; (2) faulty health habits, such as (a) the use of tea and coffee; (b) the absence of milk and cereals from the diet; (c) fast eating and irregular meals; (d) the use of sweets between

2. Holt, L. E.: Tr. Am Pediat. Soc., Arch. Pediat. **35**:339 (June) 1918.
3. Benedict, F. G., and Talbot, F. B.: Metabolism and Growth, Publication 302 Carnegie Institution, Washington, 1921, p. 33.

meals (school located a long distance from the temptation of stores, and relatives urged not to send candy to the boys), (e) sleeping with closed windows (dormitories, thus preventing individual window closing from interference), (f) overfatigue, (g) over-pressure and too long periods of work, (h) too little time in the open air; (i) irregular living due to lack of control, and (j) late hours.

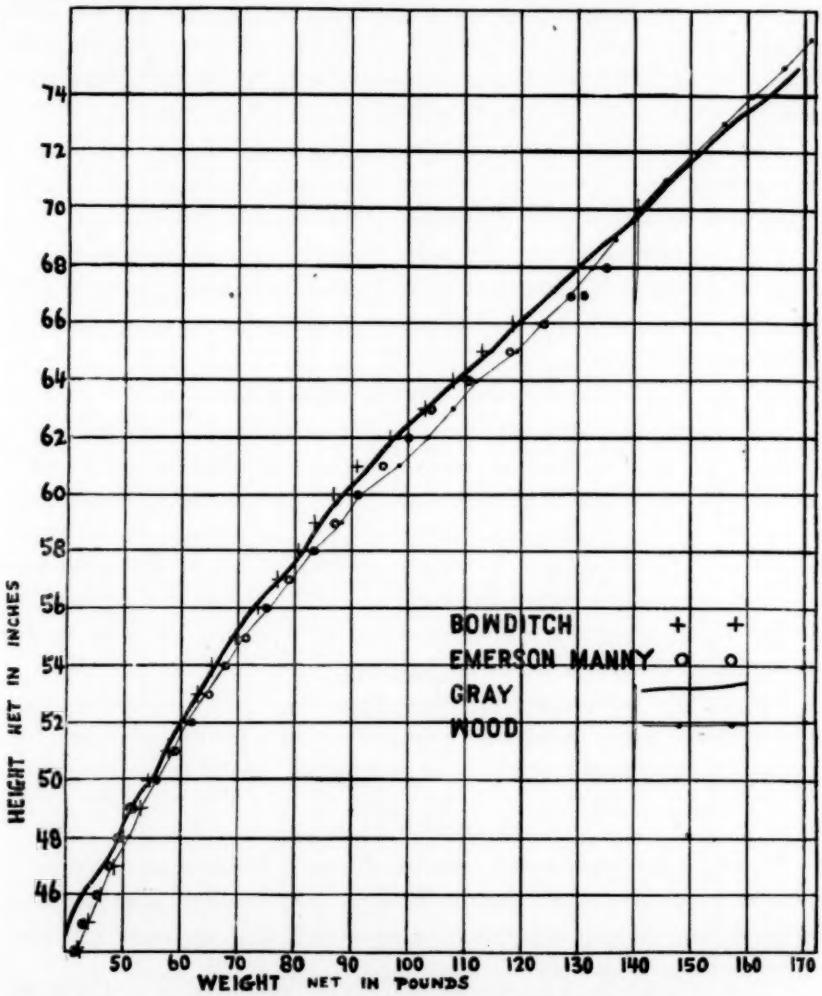

Chart 1.—Weight for height, according to different observers.

MEASUREMENTS

Observer.—The observations were made by (or under the immediate supervision of) one of us (W. J. J.), who is in constant daily attendance as full time physical director at the school.

Age.—To nearest, not last, birthday.

Height.—To nearest quarter-inch, at least. It would have been preferable to use the metric system, but this was not done out of regard for the persistence in pediatric work of the traditional English units. All measurements of height, as well as of chest-girth and weight, were made without clothes. The height should not be measured with the movable rod attached to the upright of scales, because (1) the subject is generally unable to straighten up the heels, hips, shoulders and head properly against a single rod, and (2) the small but still avoidable error due to the flexibility of the horizontal bar. Height should be measured with the subject straightened up against a wall or door.

Chest Girth.—This measurement represents the mean of the measurements taken at full inspiration and full expiration, at the level of the nipple and the angles of the scapulae; arms hanging relaxed.

Weight for Height, not for Age.—In utilizing most of the tables, it single observation is worthless, since a pound difference is easily produced by exercise or by drinking two glasses of water or eating an ordinary meal.

METHOD OF TESTING STANDARDS

This simple procedure has been described fully in a previous paper on adults.[4] In brief, the difference between the actual weight of each person and the weight as predicted for him by the method being tested, was first noted in pounds, then translated to a percentage of the actual weight. This percentage is clearly necessary, since, for example, fourteen pounds divergence from the weight of a person weighing 200 pounds is only 7 per cent., whereas in a child weighing 100 pounds, the prediction error is serious, namely, 14 per cent.

Then, these percentage deviations from the 136 calculated weights were summed and averaged, yielding the mean percentage error for the particular method (weight table or formula) under consideration.

STANDARDS STUDIED

Weight.—Stripped, to the nearest pound. Greater accuracy in a is important to appreciate that the present day view has supported and developed the cursory suggestion of Bowditch, that age is of practical

4. Gray, H., and Gray, K. M.: Normal Weight, Boston M. & S. J. **177**:894 (Dec. 27) 1917. Gray, H., and Allen, F. B.: Weight in Soldiers, J. A. M. A. **74**:1732 (July 19) 1920. Gray, H. and Allen, F. B.: Bornhardt's Formula, Boston M. & S. J. **184**:334 (March 31) 1921. Gray, H., and Mayall, J. F.: Body Weight in 229 Adults, Which Standard Is the Best? Arch. Int. Med. **26**:133 (Aug.) 1920. (This discusses other references.) Gray, H., and Root, H. F.: Stem-length and Trunk-length, Boston M. & S. J. **184**:439 (April 28) 1921. Weight Prediction by the Formulae of Bornhardt, of Von Pirquet, and of Dreyer, Boston M. &. S. J. **185**:28 (July 7) 1921.

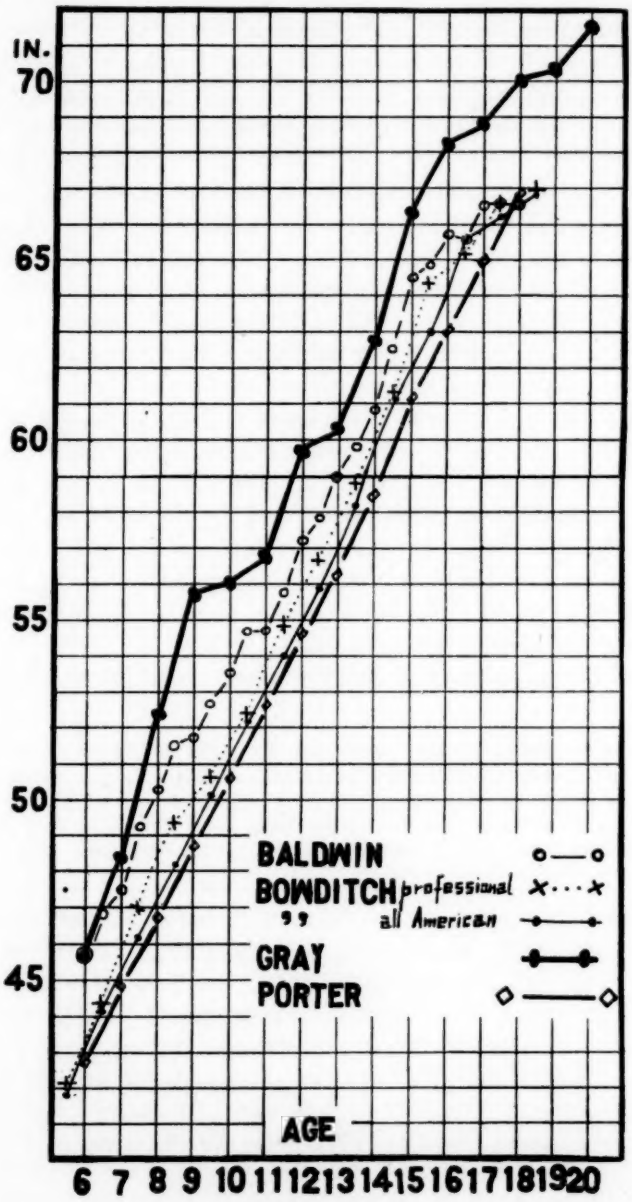

Chart 2.—Height for age.

importance only in predicting growth in height. Then, when it comes to predicting weight, or the state of nutrition, in the words of Von Pirquet (1913) "we have to compare the actual weight not with the average weight for age, but with the actual height." The same view

is held among others, by Holt (1918), Dufestel (1920), and Benedict [5] (1919), who summarizes the situation concisely:

> If the height is too small for the age, one may logically assume either that the child is the offspring of a family of normally short stature or one may suspect deficiency in the skeletal growth. On the other hand, a child may be of the normal or average height for the age and yet be definitely under weight.

While his oft-quoted original tables showed weight for age, Bowditch also calculated indirectly the weight for height. The latter table seems to have been neglected till reproduced by Holt.[6] The labor of testing this standard has been omitted, as the curve runs so close to the curve of Wood, which is more recent and is based on an even larger number of children. For the same reason no tests were made with certain other tables cited below.

In 1910, Wood published a table based on boys at the Horace Mann School. Later he found that this original table in the Ninth Year Book was based on too small a number of observations so that there was too much irregularity in these tables, and for the older and especially the taller children the weights were not high enough to be typical for the median values. These original tables were based on the mode and that seemed to Wood the most scientific, accurate basis if one has a large enough number of observations.[7]

In 1920 he gave a revised table for weights of children, of which he remarked:

> While the revised tables are based upon a number of different sources, they are made up, of course, on actual observations. I wish that we might have the tabulation of about one million boys and girls for each of three types of physique. This would give to us a very interesting basis for comparison with the tables which have been prepared. It does seem likely that we shall have such a colossal piece of work done in the near future.

The different sources which he used included at least 250,000 of each sex, and were as follows: (1) Statistics of American school children published by Baldwin,[8] Boas, Bowditch, Hastings, Holt, Porter [9] and others. (2) Statistics from about 10,000 records of children in the Horace Mann School, collected during the past eighteen years. (3) Statistics of life insurance companies for periods of fifteen years and upward. (4) Dublin's statistics of children from 14 to 16 years of age examined in New York State for the issuance of working papers.

---

5. Benedict, F. G.: Boston M. & S. J. **181**:107 (July 31) 1919 Benedict, F. G., and Hendry, M. F.: Boston M. & S. J. **184**:262 (March 17) 1921.

6. Holt: Diseases of Infancy and Childhood, Ed. 8, D. Appleton & Co., New York, 1919.

7. Wood, T. D.: Personal Communications, March 30, April 7, 1920.

8. Baldwin, B. T.: Physical Growth and School Progress, Bull. No. 10, Whole No. 581, U. S. Bureau Educ., Washington, 1914, p. 189.

9. Porter, W. T.: Quart. Publ. Am. Statistical Assn. **3**:576 (Dec.) 1893. Am. J. Physiol. **52**:121 (May) 1920.

This table was reprinted on a 4 x 5-inch card, by the Division of School Hygiene, Bureau of Education, Department of the Interior, Washington, D. C., and may be obtained by writing there. It was also reprinted in an interesting pamphlet [10] published by the Child Health Organization of America, 156 Fifth Avenue, New York City.

It is particularly to be noted that Wood's 1910 table gave net weights and heights, whereas his 1920 table gave net heights but weights with average indoor clothing.

With reference to the weight of the clothing, he considered that with the present fashions the clothing with the shoes removed, and in the case of boys with the jacket also removed, may be estimated on the

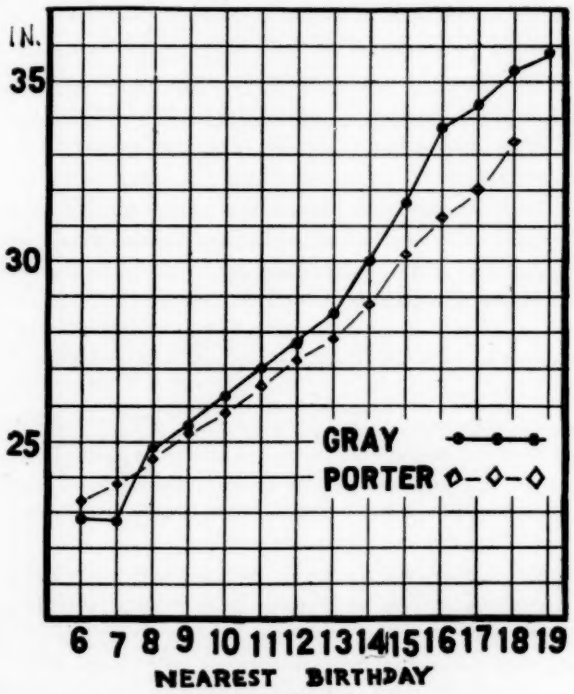

Chart 3.—Chest for age.

average of three pounds for girls, and four pounds for boys. If the child be measured in shoes, Wood recommended subtracting one inch from the height to get the net height for use with the table.

As the present subjects were measured stripped, it was necessary to adjust Wood's 1920 table (we have not used his 1910 table) by allowing for clothes. This was done in two ways: (a) by subtracting throughout four pounds as he suggested, and (b) by subtracting at different ages the corresponding varying weights of clothes as estimated

10. Holt, L. E.: 1920 Standards of Nutrition and Growth.

by Bowditch in 1877. The importance of the clothing is indicated by the divergent results: the average prediction error with method (a) was 8.27 per cent., and with method (b) only 7.17 per cent.

The Emerson and Manny tables [11] (1920) were for the early years derived from the figures given in Holt's book, that is to say, Bowditch's figures; and for school age obtained by "setting forward" by six months the "basal studies of Boas and Burk which incorporated the work of Bowditch, Peckham, Porter, Smedley, and others, aggregating in all some 90,000 measurements."

Retan [12] gave a table with shoes and clothes, and made the interesting statement that "in using the relation of height to weight as a standard, I have found that it is not necessary to remove shoes. The loss in height from the removal of the shoes compensates for the loss in weight from the shoes." His Chart 4 supports this view. Another interesting contention by him is supported by his Chart 5, plotted from the scale of Boas and Burk, "which tends to prove that a separate scale of measurements is not necessary for each sex." Like Holt, Retan says: "It is obvious that nationality plays no rôle in the measure of nutrition when the nutritional standard is represented by zones based on the relation of weight to height."

TABLE 1.—SIZE STANDARD FOR PRIVATE SCHOOL BOYS
(Referred to Age at Nearest Birthday. Based on Averages from 380 Boarding and County Day School Boys After Exclusion of Those Subnormal on Physical Examination)

Age Nearest Birthday	Height Net in Inches	Chest-Girth Mean Net in Inches	Number of Boys	Age Nearest Birthday	Height Net in Inches	Chest-Girth Mean Net in Inches	Number of Boys
6	45.7	22.9	3	14	62.8	30.0	42
7	48.1	22.8	6	15	66.2	31.7	69
8	52.1	24.8	16	16	68.2	33.7	54
9	55.8	25.3	19	17	68.8	34.3	47
10	56.0	26.2	16	18	70.0	35.2	29
11	56.8	27.0	19	19	70.1	35.8	14
12	59.7	27.6	15	20	(71.5)	(40.5)	(1)
13	60.1	28.5	30				

Some New Ideal Tables.—Independently of, but in agreement with Talbot's opinion as to the need for a new table of weight for height for boys of approximately ideal heredity and environment, one of us has collected data on 380 such persons. The material is small, but being larger than others have reported in the past, it is thought worth reporting as tentative "ideal tables." These are given herewith in Tables 1, 2 and 3 and Charts 1, 2 and 3, and will be more extensively discussed elsewhere. They permit the judgment not only of nutrition (weight), but also of development in size or bony frame (height and chest girth).

11. Emerson, W. R. P., and Manny, F. A.: Arch. Pediat. **37**:468 (Aug.) 1920.
12. Retan, G. M.: New York State J. M. **19**:397 (Nov.) 1919. Arch. Pediat. **37**:32 (Jan.) 1920.

Chart 1 shows that the tentative ideal weights for height run extraordinarily close to Bowditch's sons of professional men, but somewhat lower (higher as plotted on the chart) than the figures of Wood (after subtracting 4 pounds for clothes), and also lower than the values of Emerson and Manny (again after correcting to net values by subtracting 4 pounds).

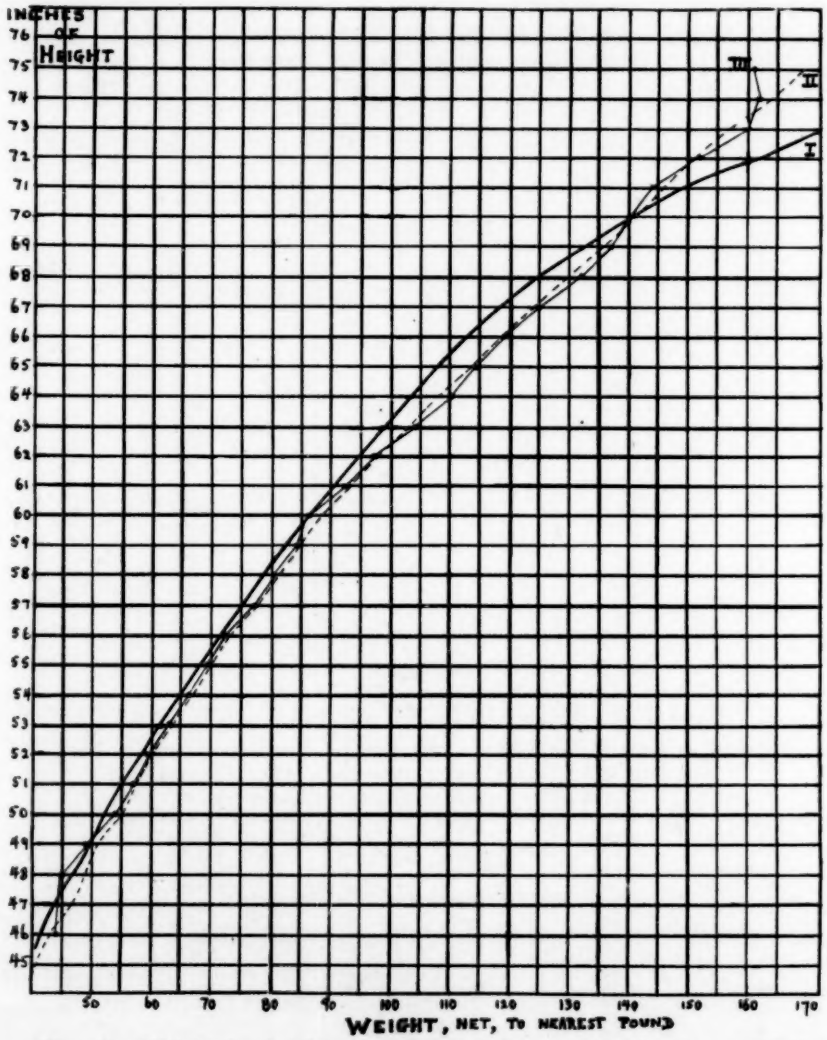

Chart 4.—Weight for height, according to different methods of consolidating 380 ideal observations.

To obtain a control on the accuracy of the ideal height by age table studied in this paper, we examined Chart 5 of Holt's 1919 article on standards for growth. We selected the curve most similar to our own,

namely; the highest height for age, that based on Baldwin's 300 cases. The other nine curves there illustrated were not thought worth experimenting with in the present connection, since presumably the error (generally with Baldwin's table on the low side of fact) would be even worse with these other tables.

TABLE 2.—WEIGHT STANDARD FOR PRIVATE SCHOOL BOYS

(Referred to Nearest Half-Inch of Height. Based on Averages from 380 Boarding and Country Day School Boys After Exclusion of Those Substandard to Physical Examination)

Height Net to Nearest Half-Inch	Weight Net to Nearest Pound	Number of Boys	Height Net to Nearest Half-Inch	Weight Net to Nearest Pound	Number of Boys
44.5	40	1	60.	86	11
45.	40	0	60.5	89	5
45.5	42	0	61.	92	11
46.	44	2	61.5	95	6
46.5	44	0	62.	97	12
47.	45	1	62.5	101	4
47.5	45	0	63.	104	6
48.	45	3	63.5	107	4
48.5	47	1	64.	110	9
49.	49	2	64.5	112	2
49.5	52	0	65.	114	18
50.	54	4	65.5	117	13
50.5	56	0	66.	119	15
51.	57	1	66.5	122	11
51.5	58	0	67.	125	11
52.	59	5	67.5	129	14
52.5	61	1	68.	132	16
53.	63	10	68.5	135	11
53.5	65	4	69.	137	16
54.	66	6	69.5	139	12
54.5	68	4	70.	140	12
55.	69	3	70.5	142	14
55.5	71	6	71.	144	15
56.	72	11	71.5	148	8
56.5	75	2	72.	152	7
57.	77	7	72.5	156	4
57.5	79	5	73.	160	3
58.	80	9	73.5	161	2
58.5	82	3	74.	162	1
59.	84	9	74.5	162	2
59.5	85	3	75.	161	1

TABLE 3.—WEIGHT STANDARD FOR PRIVATE SCHOOL BOYS

(Referred to Nearest Half-Inch Chest Girth. Based on Averages from 380 Boarding and Country Day School Boys After Exclusion of Those Substandard to Physical Examination)

Chest-Girth Net to Nearest Half Inch	Weight Net to Nearest Pound	No. of Boys	Chest-Girth Net to Nearest Half Inch	Weight Net to Nearest Pound	No. of Boys
21.5	37	1	31.5	116	14
22	40	0	32	120	13
22.5	43	3	32.5	123	14
23	47	4	33	127	19
23.5	51	1	33.5	130	16
24	54	13	34	134	13
24.5	58	3	34.5	138	24
25	62	11	35	141	22
25.5	66	8	35.5	145	9
26	70	12	36	149	18
26.5	74	7	36.5	153	7
27	78	16	37	157	7
27.5	82	16	37.5	161	5
28	86	11	38	165	1
28.5	90	17	38.5	170	1
29	94	13	39	176	1
29.5	98	15	39.5	181	0
30	103	14	40	187	1
30.5	107	16	40.5	192	1
31	112	13			

Chart 2 shows that even Baldwin's boys exhibited at each age a considerably smaller stature than the tentative ideal table; that Bowditch's sons of American professional men were even smaller, though distinctly taller than his all-American boys (usually cited); and finally that Porter's subjects (the lowest curve in Holt's Chart 5) lie vastly below our tentative ideal.

As a control, representing the current standard for chest girth (in relation to age), the best without doubt is the table published by Porter in his well-known (1893) monograph,[9] and quoted by Holt in his book.

Chart 3 shows that his subjects at all ages, except 6 and 7, had smaller chest circumferences than the boys represented by the tentative ideal table.

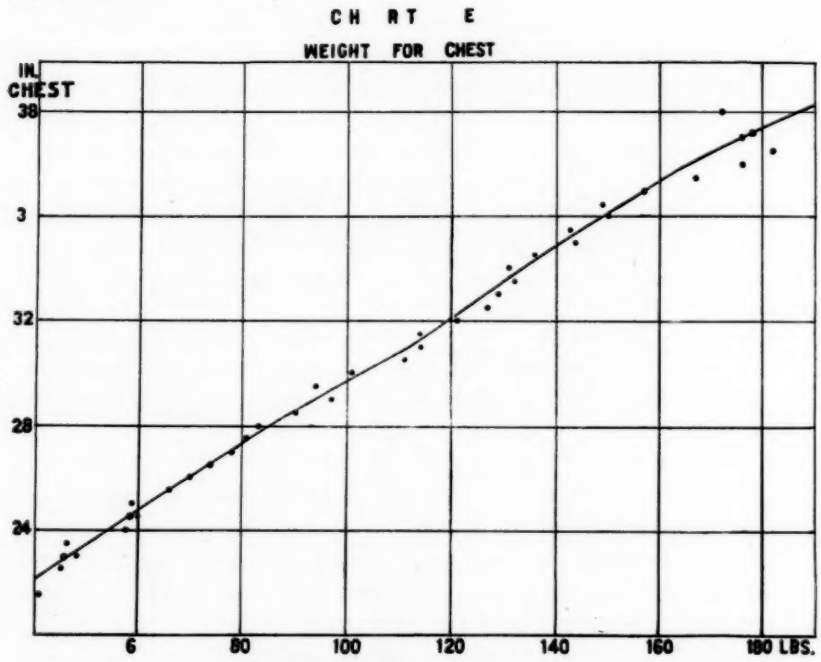

Chart 5.—Weight for chest girth.

RESULTS REGARDING HEIGHT

The relative divergence from fact on the part of the height-for-age as predicted by the two standards was:

(1) Ideal table: error, 3.78 per cent.;

(2) Baldwin's table: error, 4.92 per cent.

RESULTS REGARDING CHEST GIRTH

The estimated chest girth for age deviated from the observed girth, according to

(1) Ideal table, by 4.50 per cent.;

(2) Porter's table, by 6.52 per cent.

RESULTS REGARDING WEIGHT

The relative accuracy of the six standards for estimating normal weight was, giving the best first:

(1) Ideal table of weight-for-height and ideal table of weight-for-chest, combined: error, 4.87 per cent.

(2) Ideal table of weight-for-chest: error, 5.35 per cent.

(3) Wood's table of weight for height, minus Bowditch's varying allowances for clothes: error, 7.17 per cent.

(4) Bornhardt's formula: error, 7.25 per cent.

(5) Ideal table of weight for height according to averages by inches of height, with weights for half-inches interpolated: error, 7.57 per cent.

(6) Wood's table of weight for height, corrected to give net weight by subtracting four pounds throughout, as advised by Wood: error, 8.27 per cent.

TABLE 4.—THIN AND FAT BOYS

Difference Between Predicted Weight (PW) and Actual Weight (W), in in Percentage of Actual Weight	No. of Boys
Thin	
PW greater than W by 11 per cent. and over (maximum 16 per cent.)	11
By 1—10 per cent	61
PW = W	9
Fat	
PW less than W by 1 — 10 per cent	52
11 per cent. and over (highest 14 per cent.)	3
Sum	136

DISTRIBUTION OF THIN AND FAT BOYS IN THIS SCHOOL

The material in hand may now be regarded from another point of view, that of the individual. If the proposed ideal standard be accepted as the most suitable for judging this type of private country school boy, how do the boys in the present series measure up to it? How many are too thin? How many, if any, are too fat?

This may be roughly shown by tabulating the "percentage errors" in groups, as in Table 4.

For this purpose the better procedure would be to recalculate the difference between the predicted and actual weights, referring the percentage to the predicted weight instead of to the actual weight. The greater accuracy thus obtainable has not seemed worth the labor, for our present purposes.

The results are: (1) only eleven boys, or 8 per cent. of the series, are excessively thin; (2) only three boys, or 2 per cent., are too fat; (3) the underweights and overweights in general are about equal in number, as was to be expected, since these observations were utilized in constructing the ideal standard. This fact, it is true, to a consid-

erable degree invalidates the value of this standard for judging these particular boys individually, because the boys seem nearer normal than they may fairly be said to be. This vitiation, however, is unavoidable till an ideal table based on larger material be available.

SUMMARY

1. For judging the size and weight of children of the "higher economic classes" (Faber [13]), i.e., of boarding and country day-school boys (not including private schools in the city), totally new standards are necessary.

2. Such standards are tentatively offered, for predicting (and judging the normality of) weight, height, and chest girth.

3. These standards, together with representatives of current standards, are tested by the simplest and briefest mathematical method (laborious at that, thus probably explaining the lack hitherto of such data).

4. The results are sufficiently favorable to the proposed methods to indicate further study, and this has been done on data obtained from a similar boarding school, Middlesex, at Concord, Mass.[14]

We are indebted for the opportunity to make this study to the founder and present headmaster of the school, the Reverend Endicott Peabody.

13. Faber, H. K.: Arch. Pediat. **37**:244 (April) 1920.

14. Gray, H.: Size and Weight in 130 Boarding School Boys (Middlesex) M. Clin. of N. America, May, 1921.

IDEAL TABLES FOR SIZE AND WEIGHT OF PRIVATE SCHOOL BOYS

H. GRAY, M.D.
BOSTON

PART II

Ideal vs. Normal.—The necessity for this distinction regarding weight standards in general has been set forth by the Medico-actuarial Committee 1912, by me in 1917, and by Benedict and Talbot in 1921.

Regarding boys in particular, as long ago as 1877 and 1879 Bowditch observed that children of the professional and mercantile classes are larger than those of the laboring classes, and also (a paradox, now explicable by the statements of Benedict and Talbot) that among the latter the weight of the children of the skilled is less than that of the sons of the unskilled. Presumbably, that means, weight less in relation to height.

Different standards for the different classes seem, however, not to have been considered seriously, until in Germany, Camerer, in 1901, published observations from his office practice, and Friedenthal, in 1914, maintained that what he called the "cultured type" must be judged by standards differing from those customarily applied by pediatricians to the general run of boys.

Freeman [15] in this country reported weights and measurements of infants and children in private practice (278 cases) compared with institution children and school children (500 cases). This progressive article considered younger children than those here investigated.

The principle at issue (on which are based the ideal tables proposed) was then urged by Benedict and again more emphatically by Benedict and Talbot in an extremely interesting discussion of the "normality of children."

"If objection be made to considering the data on private school children as being normal, none can be made to denominating these as ideal. Hence, the height and weight of a child should be compared not with the fictitious or average normal, but with the ideal, which is unquestionably represented more nearly by our data from private schools."

ANTHROPOMETRIC MEASUREMENTS AS INDICES OF GROWTH

Weight for Age.—This classic relationship is of interest chiefly because it has been studied by so many, and has taught us so much. Benedict and Talbot [3] show in their Figures 3 and 4 a variety of curves,

15. Freeman, R. C.: Tr. Am. Pediat. Soc. **26**:202 (May) 1914.

the relative position of which they point out as being of very great importance. The weights in the two foreign curves (Quetelet and Schmid-Monnard) practically throughout were "measureably" lower than the weights of miscellaneous American boys of the same ages (Crum; Wood;[16] Benedict and Talbot's laboratory children), while these, in turn, were lighter than well-to-do boys in private city schools (Holt's Browning School boys), and these again lighter than well-to-do boys in country schools (Benedict and Talbot's private school boys).

Weight for Height.—More than forty years ago, Bowditch gave weights for height, regardless of age, and also proposed as a desideratum the average weight corresponding to each height for each age. Such tables were published by Wood in 1910 and 1920, while tables in the simpler and satisfactory form of Bowditch's earlier table have been especially brought into favor by Holt (in May and December, 1918), Benedict (1919), Retan (1919), Emerson and Manny (1920), and Benedict and Talbot, (1921). The wide experience of these several students of child physiology agrees in discarding the older reference of weight to age in favor of weight for height.

Weight for Chest Girth.—With the conclusion just noted, obvious as it is from the data so far published, one exception may be taken—the weight follows the chest curve more nearly than the height curve. This relationship seems to have been noted by Allaire (1863), Schlesinger[17] (1917), Dreyer (1920), and is supported by my evidence. Gould (1869) seems to have published the only table of weights for chest girths in Americans.

Hence, for intelligent consideration of growth one needs to measure (1) skeletal growth, as Benedict and Talbot have indicated (and to their regard for height we wish here to urge again greater regard for skeletal width, as measured most conveniently by chest girth) and (2) the amount of flesh proportionate to the bony frame.

Height for Age.—Emerson and Manny[11] have rather disparaged "the basis of height for age as even more confusing than weight for age, because many of the children most in need of care are above the average scale of height for their years." The relationship is, however, thought of great value and will be further discussed.

That the increasing weight for age found by each of the authors mentioned is due mainly to the greater height for age in the successive groups is shown by Benedict and Talbot in their Figure 4. There the same progression is seen: The smallest boys, in reference

16. Benedict and Talbot, 1921, p. 37, apparently from reliance on a reprint, which displaced Table 3 of my first paper (Gray, H.: Boston M. & S. J. **177**:894, 1917) erroneously connected Professor Wood and the Life Extension Institute.

17. Schlesinger, E.: Ztschr. f. Kinderh. **16**:265, 1917.

to age, were those of Quetelet, then Schmid-Monnard, Benedict and Talbot's laboratory children, Crum and Wood, Holt's private school boys in the city and, finally, the tallest were Benedict and Talbot's private school boys in country schools. They thus demonstrated a distinctly better type of youth in our private schools.

Chest for Age.—This relationship has been considered but little, except by Porter,[9] but is considered of sufficient import to be reverted to below, in presenting a new ideal table for a special class of boys.

Benedict and Talbot in their Figure 7 plotted the weight for height, without regard to age, of their laboratory boys and again of their private school boys, and thus made indisputably clear that the latter weigh less for a given height. To this striking relationship they give special consideration, from which it appears that private school boys develop in frame more rapidly than public school boys, are "rangier" (Benedict) than public school boys. Hence, they appear paradoxically deficient in weight relative to height, though their absolute weight relative to age excels that of miscellaneous boys. "The relationships of weight to height are of most importance," these two authors are convinced, but they also admit the possibility of progress by means of other anthropometric measurements:

> Still, in a subject as important as this, it is desirable to make use of every conceivable measurement that may possibly contribute toward clarifying the problem as to what is the normal state of nutrition. Many writers have used, in addition to height and weight, typical measurements, such as the girth around the chest or the abdomen at the level of the umbilicus, the height of the subject sitting, and other measurements. Pediatricians have not, however, accepted any of these generally. To show at a glance whether the individual is well nourished or poorly nourished we need some matematical expression of relationship between either weight or height and one or more girths.

Such a relationship was urged by Bornhardt, in 1887, and was studied at the time by certain other Russians, and more recently in this country.[4] The present paper uses the chest girth as well as the height to arrive at the proportionate weight to be expected. And very lately still another effort to utilize the chest girth has been made by Dreyer, who for height uses, instead of stature, the distance vertex to ischial tuberosities. These intensely interesting considerations are now being tested and will be discussed elsewhere.

FACTORS AFFECTING GROWTH

A number of these factors have been discussed extensively by others, but are of so much importance that they may be recapitulated.

Nationality.—Both the nation and racial elements within the nation. This affects height more than weight.

Environment and Social Status.—The literature is referred to, especially Villermé (1829), Burk (1898) and Robertson (1916), by Benedict and Talbot,[3] who summarize experience as follows:

> Those children who live much out of doors and whose families can afford to supply them with good and sufficient food obtain better growth than children of the same nationality and locality who have not had the same opportunity.

Food Quantity.—Caloric deficiency retards weight-nutrition rather than height, according to Waters,[18] and Benedict and Talbot, 1921.

Food Quality.—Dietary deficiencies, the lack of vitamins or food accessories, stunt height rather than weight, according to Osborne and Mendel,[19] McCollum,[20] Jackson and Stewart,[21] Benedict and Talbot.[3]

Excessive Exercise.—The devitalizing influence of competition has often been discussed, for example, by Emerson,[1] and by Benedict and Talbot.[3] This factor hinders nutrition (weight) more than skeletal growth.

Insufficient Rest Periods.—The value of rest in conserving the energy of children has been graphically described by Hill [22] in reporting the foresighted practice in Germany during the war:

> The mothers of Germany kept their war-starved children most of the day in bed, letting them get up at 11 a. m. and go to bed at 4 p. m. Thus they husbanded the national life, taught by scientific experience that growth will make good when the war is over and food supplies become ample.

Physical Defects and Medical Supervision.—These have been discussed by various authors such as Robertson,[23] Emerson [1] (particularly exhaustive), and Benedict and Talbot.[3]

USUAL TABLES

In two papers on the size and weight of boarding school boys (Groton and Middlesex) we have recently reviewed the customary standards in more or less general American pediatric use today, namely:

(A) *For Weight*: Bowditch, 1877; Wood, 1910 and 1920; Retan, 1919; Emerson and Manny, 1920.

---

18. Waters, H. J.: Pros. Soc. Promotion Agricul. Sc., Washington **29**: 71, 1908.

19. Osborne, T. B., and Mendel, L. B.: Publication 156, Carnegie Institution, Washington, D. C., 1911.

20. McCollum, E. V.: The Newer Knowledge of Nutrition, New York, 1918. Nutrition and Physical Efficiency, Franklin Institute, April, 1920.

21. Jackson, C. M., and Stewart, C. A.: Am. J. Dis. Child. **17**:329 (May) 1919.

22. Hill, L.: The Science of Ventilation, Part I, Special Report, Series 32, Medical Research Committee, London, 1919, p. 79.

23. Robertson, T. B.: Arch. f. Entwicklungsmechanik **25**:595 (May 19) 1908. Am. J. Physiol. **41**:553 (Nov. 1) 1916.

(B) *For Height*: Bowditch, 1877 and 1879; Peckham, 1881 and 1882; Barnes, 1892; Boas, 1892, 1895, 1904; Porter, 1893 and 1894; West, 1894; Macdonald, 1898; Hastings, 1900; Smedley, 1900; Baldwin, 1914.

(C) *For Chest*: Porter, 1893.

Conflicting Tables.—The inevitable bewilderment resulting from the variety of standards, of which only the more prominent are recited above, is well pictured by the following official statement:

There having been much discussion regarding the various height and weight tables for children published by the different organizations, and, apparently, some confusion and doubt having arisen in the minds of many teachers and health workers regarding the accuracy of the different tables, it has long been felt that it was desirable for the principal organizations which were putting out tables to meet in conference and consider the possibility of adopting a uniform table which would be acceptable to all.

For this purpose a meeting was called in New York, Dec. 3, 1920, by Dr. L. Emmett Holt, chairman of the Child Health Organization. A second meeting was held March 24, 1921. From this conference a national committee has been organized composed of the following members:

Prof. Bird T. Baldwin, representing the State University of Iowa.

Dr. Taliaferro Clark and Mr. Edgar Sydenstricker, representing the U. S. Public Health Service.

Dr. William R. P. Emerson and Mr. Frank A. Manny, representing the Nutrition Clinics for Delicate Children.

Dr. S. McC. Hamill, representing the American Child Hygiene Association.

Prof. William T. Porter, representing the Harvard Medical School.

Dr. Anna E. Rude and Dr. Robert M. Woodbury, representing the Federal Children's Bureau.

Mrs. Ira Couch Wood, representing the McCormick Memorial Fund.

Dr. Thomas D. Wood and Dr. L. Emmett Holt, representing the Child Health Organization.

The various tables now in use have been considered critically and it has been found that there was substanial agreement in the figures used by all, the difference being chiefly a matter of presentation or statement.

Dr. Baldwin has been appointed to draft a table embodying the suggestion made, to be presented at a subsequent meeting. This, it

should be emphasized, is not encroached on by this paper, which considers special tables for a special superstandard stratum of American boyhood.

Vitiated Tables.—Emerson brought forward an error common to most of the above standards, and Emerson and Manny expatiated on the idea as follows:

"All tables of weight and height now in use are vitiated by the fact that they contain the measurements, not only of those who have accomplished normal growth, but also the 20 to 40 per cent. group who are habitually underweight for their height, as well as an undetermined number less under weight but presenting other signs of malnutrition."

Their experience shows, like that of Benedict in the Shattuck Lecture for 1919, that the underweight children are not at all balanced by overweights, thus differing significantly from the equalization which is expected from averaging, and which is granted by that observer actually to result from averaging adult weights. He has said that the number of overweight children is much smaller than the number of underweights, and that on this ground, therefore, an average value for children seems wholly erroneous. With this proposition one readily concurs when the children observed are taken at random from public schools. But when the children are taken from the selected class existing in private schools, and are subjected to further selection by omission of those abnormal on history or on physical examination, then we venture to maintain that averages are truly representative.

Healthy Variations from the Averages.—Statistically, of course, one would demand the degree of dispersion of the individual children from the average or dominant (Lange, 1903), but such a measure of scatter (standard deviation, or better the coefficient of variation) seemed not worth the labor of calculation in the present relatively small series. Another measure of the spread of values is the range, deducible from the double entry (height and age, to find weight) tables of Wood (1910 and 1920); also from the "standard lives" of the Medico-actuarial Committee, 1912, or the "norm of weight" of Gaertner (1913). The importance of the subject has been urged also by Chose and Dikanski (1914), by Pfaundler (1916), by us (1917 and 1920), by Holt (1918), who introduced the convenient term "zone," by Retan (1919), and by Emerson and Manny (1920). This phase requires further study and will not be continued here.

IDEAL MATERIAL

The material from which the present tentative ideal tables have been constructed consists of three groups, each presented elsewhere:

1. Groton School: 136 boys, aged from 12 to 19 years.
2. Middlesex School: 130 boys, aged from 12 to 20 years.
3. Rivers' School: 114 boys, aged from 6 to 18 years.

This gives a total of 380 subjects, a rather small group, but yet larger than groups reported by some others and apparently found of interest in the literature. Owing to this small number, the proposed tables can be considered as being only tentative, but may be fairly reasonably regarded as ideal. For it may be seen in our other papers that this material has been combed to exclude subjects who are sub-standard according to physical examination and even according to history (as furnished by intelligent and interested parents), and this combing has been the more careful in each succeeding series of the three studied.

MEASUREMENTS

The observations were made as follows:

(1) Age to nearest, not last, birthday. As Bowditch (1877) and Robertson (1908) have remarked, when the age is recorded as of the last birthday, we must assume the average age for that group to be six months greater, and corresponding corrections have been made in the values reported by various observers in order to facilitate comparison.

(2) Height and chest girth to nearest quarter-inch, at least, without clothes.

(3) Weight to nearest pound, without clothes.

CONSOLIDATION OF IDEAL MATERIAL INTO IDEAL TABLES: SIZE OR DEVELOPMENT

The mean height-for-age and chest girth-for-age is given in Table 1. These figures are also plotted as curves, for comparison with current standards, in Charts 2 and 3 of our paper on Groton boys.

How far the superior dimensions of these children are due to their American parentage and how far to their advantages seems to be as much an open question as when it was first posed by Bowditch in 1877.

WEIGHT

Scatter Diagram.—The first step was to plot 380 dots, each representing both height and weight of one boy. The separate comparison of tall and heavy boys at one of the schools with the small and lighter boys at another school might be worth analyzing, but is not considered here because the number of observations is felt to be inadequate for the purpose. In order to consolidate this spot chart into utilizable shape, a smoothed curve was then tried.

Smooth Curves in General.—The terms smoothed curve, smooth curve, smoothing, sketched curve, hypothetical or arbitrary curve, general trend line, have been used in connection with weight charts by Benedict (1919), Harris and Benedict (1919), Faber (1920), Benedict and Hendry (1921), and Benedict and Talbot (1921). The last named furnished a satisfactory description of the procedure. They plotted all the numerous measurements, and then through the plotted points a smoothed curve, representing the general trend, was drawn on tracing paper by each of five members of the laboratory staff. With the five tracings overlaid, these curves were then combined by the eye. This procedure, they say, "is admittedly unmathematical."

Sinuosity.—Weight curves have rather generally taken the form of simple curve in a single direction, most often a parabola. But the "curves" here presented are somewhat wavy, especially the line connecting average points. This alternation conforms in some measure to the periodic accelerations and retardations of growth pointed out among others by Malling-Hansen (1883); to the Wachstumsrythmus of Schmidt (1892-1893); to the "shoots" so often obscured by the generalizing method, as pointed out by West (1894); to the "growth cycles" of Robertson (1908); the S-curve of Friedenthal (1914); the variations of Bleyer[24] (1917) and of Porter (1920). The latter has particularly urged the unmasking of seasonal variations by the wider use of the "individualizing" method.

This sinuosity has been retained consciously and no attempt has been made to smooth this compound curve into a perfectly simple curve, because the curve as drawn is felt to represent our observations more accurately than a simple curve and also to emphasize the growth rhythm. This divergence need not concern us much, since on account of the relatively few observations this can be considered a standard only tentatively. More important, and indeed vital for our purpose, is the excessive bulge of this curve (in the range from 100 to 130 pounds) away from the two other lines to be mentioned below.

Smooth Curve Through Field of 380 Dots (Method I).—This method is apt to impress anybody who has not used it, as being totally unreliable. In practice, however, one is startled to notice the extraordinary degree to which these five curves coincide. In the present case, the five observers agreed essentially (within from ½ to 2 lbs.) throughout the lower three fourths of the curve. In the last quarter of the curve (i.e., above about 140 pounds), the five observations differed increasingly up to the end of the curve, at which point (170 pounds) the difference between the highest and lowest weight curve represented

24. Bleyer, A.: Arch. Pediat. **34**:366 (May) 1917.

about an inch of stature. This divergence is obviously due to the relatively small number of observations at these high weights, and, therefore, this free-hand curve is not reproduced.

Smooth Curve Through Weight Averages for Each Half Inch of Height (Method II).—This line was drawn by four observers with extraordinary unanimity.

The average (mean) has been used, since (1) within so small a series as this the separate groups exhibit rather scattered values, hence the determination of the mode or of the median value is less satisfactory than of the mean; (2) as indicated by Porter (1893), West (1894), Smedley (1900), and others, the difference between means, medians and modes are relatively insignificant for purposes such as the one under discussion.

Speaking of statistical constants, allusion may be made to the probable deviation, found useful by Porter (1893) as a measure of the physiological difference between the individual and the type; and to the standard deviation which was considered by West (1894) of very particular value to exhibit the peculiarity of each curve. The subject has been discussed elsewhere at length, and here it need only be said that the calculation of such constants entails an amount of labor which appears unwarranted in view of (1) the lack of interest at present among medical men in biometric details; (2) the entire lack of data on boys strictly comparable to those here considered (although it would be interesting to attempt to confirm the findings of Pfaundler's pupil Dikanski as to greater deviations from the average in well-to-do compared with poor children, if his dissertation were available for study), and (3) the hope of enlarging the present number of 380 subjects, and then studying the coefficient of variation (standard deviation divided by mean) as a control on the present admittedly arbitrary zone extending variously 7, 10, 15 or 20 per cent. below and above the dominant or average normal curve.

Point-to-Point Line Through Weight Averages for Each Inch of Height (Method III).—This line seemed also worth testing, despite its irregularity. In grouping the weights preparatory to averaging, they were assembled in classes from 0.5 to 0.4 inclusive, not 0 to 0.9; i.e. the group 65 inches included the boys (thirty-one in number, as it happened) whose statures varied from 64.5 to 65.4 inches inclusive, while 66 inches covered the class-interval 65.5 to 66.4, and so forth.

Comparison of the three preceding curves may be made in Chart 4 visually. The chart was presented to three observers for judgment, and each rejected the heavy line (I: smoothing of 380 dots) as too divergent, while preferring between the other two the dash-line

(II: smooth curve through averages by half-inch heights). This optical choice was then tested numerically by predicting by each of Curves II and III the weights of 265 (Groton and Middlesex boys) out of the 380 individuals, finding the 265 differences between theoretical weights and observed weights, expressing these differences as prediction errors in per cent. of the observed weights, and finally calculating the average percentage prediction error for each curve.

This error for the smooth dash-line II was 7.20 per cent. versus 7.08 per cent. for the irregular point-to-point line III. In other words, contrary to the visual test, figures favored by a slight margin the weight-averages by inches of height.

Tentative Ideal Table of Weight for Height.—The proposed standard, therefore, is that last named in the preceding paragraph; with the refinement of interpolated weights for half inches of height. This ideal table for judging private boys in country schools is accordingly offered tentatively (till more data shall accumulate) in Table 2 and Chart 4. For comparison with current curves this table has been shown in Chart 1 of our paper on Groton boys.

Tentative Ideal Table of Weight for Chest.—In similar manner, the weights referred to chest girths were consolidated. First, a 380 spot diagram, and second, a smoothed curve through weight averages by half inches of chest girth. The latter was thought sufficiently satisfactory, in view of the small numerical difference between the second and third methods tested above on weight-for-height, and so we omitted the extra labor of calculating further weight-averages. This proposed standard is therefore shown in Chart 5 and Table 3. One step in drawing Chart 2 may be mentioned—before drawing the free-hand trend, three circles were plotted at the two ends of the field to consolidate the scatter, namely, for four, three, and five dots, respectively.

IDEAL TABLES IN PRACTICE

Manner of Use.—The use of the size table (Table 1) is obvious. For weight the two proposed tables are to be applied simultaneously, reading off from Table 2 the weight-for-height, and from Table 3 the weight-for-chest, then averaging these two weights.

Accuracy.—Graphic comparison between standards has been the usual method; that is, by means of diagonal lines appropriately curved, running from the left upward toward the right on squared paper. This method is illustrated in the articles by Holt (1918), Retan (1919), Emerson and Manny (1920), Benedict and Talbot (1921) and in our recent paper on Groton boys. The method gives a good general impression but no quantitative measure of the extent of divergence of any

curve from the others or from observed data. Hence we prefer numerical comparison, for example, by calculating the percentage prediction error.

Weight Prediction.—This error on the part of several standards in predicting the weight of 266 Groton and Middlesex boys is, therefore, summarized in Table 4.

TABLE 4.—ERROR IN WEIGHT PREDICTION
(Subjects: 266)

Rank in Order of Accuracy	Standard	Average Percentage Prediction Error
1	Combined ideal tables	4.55
2	Ideal weight for chest	5.18
3	Wood's table corrected by subtraction of Bowditch's varying values for clothing	6.84
4	Ideal weight for height	7.08
5	Bornhardt's formula	7.09
6	Wood's table corrected by subtraction throughout of his estimated 4 pounds of clothing	7.39

Distinctly the least error is shown by the combined ideal tables. A few comments may be made regarding Bornhardt's formula, which here makes so poor a showing. Inasmuch as this formula has been elsewhere [5] shown to be in adults superior to the insurance and other well known standards, we have been interested to determine the point at which it loses applicability. This point of demarcation appears to be the beginning of puberty, about age 14, or expressed in weight, about 110 pounds (55 kg.). After discarding from the above 266 boys those below this arbitrary line, we find for the remainder that Bornhardt's formula is a close rival of the combined ideal tables, as shown in Table 5.

TABLE 5.—ERROR IN WEIGHT PREDICTION
(Subjects: 197)

Rank in Order of Accuracy	Standard	Mean Percentage Prediction Error
1	Combined ideal tables	4.35
2	Bornhardt's formula	4.52
3	Ideal weight for chest	4.79
4	Wood minus 4 pounds	6.50
5	Wood minus Bowditch's values	6.61
6	Ideal weight for weight	6.89

On the other hand, for the sixty-nine males below the age of puberty, Bornhardt's formula was useless; giving an error of 14.4 per cent. And similar results were obtained from application of that formula to Bowditch's average height and chest girth for each age, followed by calculation of the percentage deviation from the average weight given by Bowditch for that age. The prediction error was 113 per cent. (!) at birth, 53 per cent. at 6 months, irregularly decreasing to 23 per cent. at 12 years, then more rapidly decreasing to 18 per cent. at 13, 13 per cent. at 14 (i.e., about the same as on the sixty-nine boys above cited), then abruptly to 7 per cent at 15, and 5 per cent. at 16 years.

Size Prediction.—The tentative ideal tables seemed to predict nearer to observation than did the tables used as controls. For 252 heights: (1) Ideal, average error, 3.49 per cent.; (2) Baldwin, 4.58 per cent. For 253 chest girths: (1) Ideal, 4.25 per cent.; (2) Porter, 6.37 per cent.

SUMMARY

1. For judging the normality of the height, chest girth, and weight of private school boys, different tables are necessary from those available hitherto.

2. Such ideal tables are tentatively presented.

3. Evidence is offered to indicate that these tables are more accurate than those at present available.[25]

---

25. Most of the references are listed in our previous papers or in the excellent annotated bibliography in Baldwin's (1914) monograph.[8] The footnotes in this paper refer to the additional articles consulted.

A BACTERIOLOGICAL STUDY OF THE FECAL FLORA OF INFANTS AND CHILDREN (THE LACK OF ASSOCIATION OF NUTRITIONAL DISORDERS WITH A SO-CALLED "PUTREFACTIVE" INTESTINAL FLORA) *

WILBURT C. DAVISON, M.D., AND L. V. ROSENTHAL, M.D.
BALTIMORE

INTRODUCTION

James Jackson [1] of Boston, in 1812, attributed "the chemical changes which take place in the contents of the stomach and bowels of children dying of diarrhea to the putrefaction of animal food and the acetous fermentation of that which is vegetable." Since then there have been numerous attempts, at first philosophic and later bacteriologic, to establish a relationship between putrefactive and fermentative stools and certain clinical symptoms. The recent work of Porter, Morris and Meyer,[2] deserves attention. They have suggested that it is possible to differentiate between "putrefactive," "fermentative" and "normal" stools by the bacteriologic action of feces on various types of culture mediums. The statement is made that a strongly "putrefactive" flora is associated with certain groups of intestinal disorders of infancy, and that clinical and bacteriologic improvement is frequently accomplished in these patients by a strict carbohydrate diet. If these conclusions are justified, a distinct advance has been made in the diagnosis and treatment of one group of intestinal disorders in children. To verify their findings, we studied first by their methods and later by a slightly modified technic 126 stools from seventy-five infants. Fourteen of these were normal infants fed on woman's milk alone; eleven were normal infants receiving woman's milk and supplementary feedings of modified cow's milk; thirty-six were normal infants receiving modified cow's milk and soft diet; fourteen were infants with intestinal disturbances fed on protein milk, buttermilk or soft diet.

---

* Received for publication, Feb. 8, 1921.

* From the Harriet Lane Home, Johns Hopkins Hospital and the Department of Pediatrics, Johns Hopkins University.

1. Jackson, J.: Some Remarks on the Morbid Effects of Dentition, New England M. & S. J. **1**:12, 113, 329, 1812.

2. Porter, R. L.; Morris, G. B., and Meyer, K. F.: Certain Nutritional Disorders of Children Associated with a Putrefactive Intestinal Flora, Am. J. Dis. Child. **18**:254 (Sept.) 1919.

Morris, G. B.; Porter, R. L., and Meyer, K. F.: The Bacteriologic Analysis of the Fecal Flora of Children (with Notes on the Changes Produced by a Carbohydrate Diet), J. Infect. Dis. **25**:349, 1919.

Diet and Intestinal Bacteria, Editorial, J. A. M. A. **73**:1844 (Dec. 13) 1919.

METHODS

Collection of Stool Specimens.—Each stool was passed directly onto a clean napkin. These had been sterilized previously, but inasmuch as they had been handled by nurses and were placed in contact with the infants' buttocks, they could not be regarded as sterile. The use of sterile gauze by Porter, Morris and Meyer is open to the same criticism.

The samples were cultured within a few hours after collection, and during the interval they were kept in an ice box.

Our final routine technic was to inoculate with a loopful of undiluted feces, each of the following mediums:

1. (a) Gelatin stab tube (melting point 28 C.); (b) Loeffler's serum slant; (c) 1 per cent. lactose peptone water (in a Durham fermentation tube); (d) Brom-cresol-purple-milk[3] (in a Smith fermentation tube); (e) tenth-normal acetic acid veal broth (no glucose added); (f) Petri plate of Endo's lactose agar medium.

2. A lump of feces the size of a bean was emulsified in 2 c.c. sterile physiologic sodium chlorid solution and heated at 80 C. for ten minutes to kill non-spore forming organisms. The following mediums were inoculated with 0.5 c.c. of this spore material:

(a) Deep tube of brom-cresol-purple-milk (previously boiled to remove dissolved oxygen); (b) deep tube of melted agar at 45 C. (previously boiled to remove dissolved oxygen); (c) Petri plate of Endo's lactose agar medium.

The gelatin tube was left at room temperature for twenty-eight days and inspected at intervals.

The other cultures were incubated at 37.5 C. for seventy-two hours and the reactions read daily.

In our earlier work we adhered strictly to the technic outlined by Porter, Morris and Meyer. An analysis of the results thus obtained led us to substitute the simpler method just described for the following reasons:

(1) Preparing a stock dilution by emulsifying 500 mg. of the stool in 50 c.c. of saline was no more accurate than using the undiluted specimen, for the consistency of stools and their water content vary considerably. By either method only approximately the same number of organisms can be inoculated in the various mediums. Furthermore, different results were frequently obtained by the use of diluted and undiluted specimens of the same stool so that one or the other and not both methods had to be adopted.

(2) The microscopic examination of gram stained specimens of stools and the differential counts of the various types of organisms, as other investigators have noted were very misleading and therefore discarded.

(3) Plating procedures and total colony counts were unreliable criteria for the comparison of different specimens because the consistency of stools is too variable.

(4) The addition of ox bile to the lactose peptone water media had no advantages.

(5) Anaerobic cultures made in museum jars from which the oxygen was exhausted (Buchner method) (6) gave no more information than was obtained by deep tube agar (Veillon) cultures.

Types of Stool Flora (as described by Porter, Morris and Meyer[2]).

The main biologic characteristics of a "pronounced putrefactive flora" are "the rapid liquefaction of gelatin, of Loeffler's serum slants and of the milk curd and the appearance of a large spreading surface growth covering the entire plate of Endo medium surrounding small groups of *B. coli* and possibly streptococci. The reaction of the Endo medium was usually strongly alkaline; stormy fermentation (*B. welchii*, etc.) is produced in the anaerobic milk tube, and growth occurs on the lactose agar spore plate (aerobic)."

---

3. Ford, W. W.; Blackfan, K. D., and Batchelor, M. D.: Am. J. Dis. Child. **14**:354 (Oct.) 1917.

Feces with a "semiputrefactive flora" differ from those with a "pronounced putrefactive flora" by liquefying gelatin less rapidly, and by showing no growth on the lactose agar spore plate (aerobic).

A bacteriologic analysis of a "pronounced fermentative stool" will show complete absence of liquefaction of gelatin and of the Loeffler's serum slant; acid reaction of the Endo plate with a comparatively low count of the aerobic organisms; and a predominance of the aciduric organisms. There is no stormy fermentation of the anaerobic milk tube and no growth on the lactose agar spore plate (aerobic). A "semifermentative stool" differs from this only in the production of a slight amount of liquefaction of gelatin and of the Loeffler's serum slant on the third day.

A normal stool is somewhat variable and will give reactions more or less midway between these two extremes. The essential characteristics appear to be partial liquefaction of gelatin and of the Loeffler's serum slant and an absence of a spreading alkaline growth on the Endo plate.

TABLE 1.—CULTURAL REACTIONS OF VARIOUS TYPES OF STOOL FLORA (ACCORDING TO PORTER, MORRIS AND MEYER[2])

Type of Stool Flora	Aerobic Endo Plate			Growth in N/10 Acetic Acid Broth	Liquefaction of Loeffler's Serum Slant	Liquefaction of Gelatin Stab Culture	Gas Production (Percentage) in Lactose Broth	Gas Production (Percentage) and Reaction in Brom-cresol-purple Milk	Reaction of Spore Material (Heated) in Milk Tubes	Growth of Sport Material on Aerobic Endo Plates
	Spreading Alkaline Growth (B. proteus)	B. Coli Broup	Streptococcus Fecalis							
Pronounced putrefactive..	+	+	+	±	++	++ (2)	35	+ 5 pept +	++ S. F.	+
Semiputrefactive.....	+	+	+	+	++	+ (3)	45	+10 pept +	++ S. F.	0
Pronounced fermentative	0	+	+	++	0	0 (3)	30	+16 no pept	0	0
Semifermentative.....	0	+	+	++	±	± (3)	30	+40 no pept	0	0
Normal type I.....	0	+	+	+	±	+ (3)	22	+ 7 pept +	0	0
Normal type II.....	0	+	+	+	+	± (3)	25	+12 no pept	++ S. F.	0

±, + and ++ indicate degree of growth and reaction; pept, peptonization; S. F., stormy fermentation (B. welchii, etc.); (2) and (3) indicate day of appearance of liquefaction in gelatin; 0 indicates no growth or reaction within 72 hours.

It would seem that the reactions of these different flora in the other media used, i. e., lactose peptone water, brom-cresol-purple-milk and tenth-normal acetic acid broth, are too variable for differentiation.

In Table 1 we have expressed some of the cultural reactions of the various types of stool flora described by Porter, Morris and Meyer. We shall use their definitions of "putrefactive," "fermentative" and "normal" flora in discussing our results.

In Table 2 we have arranged the 126 stools from seventy-five infants as nearly as possible according to the definitions of Porter, Morris and Meyer. It was impossible in some cases to adhere absolutely to this classification in all of its details for many gradations and intermediate reactions occur. For instance, if a stool shows an

alkaline spreading growth on Endo's medium, it must in all probability be "putrefactive," or "semiputrefactive," yet this stool may produce more than 45 per cent., gas in lactose broth which appears to be the upper limit described for this type of flora, and there may have been no stormy fermentation of the anaerobic milk tube and *B. welchii* may not have been present. Again, there may have been no liquefaction of the Loeffler's slant or gelatin stab culture which would indicate that the stool was fermentative, yet *B. welchii* may have been present. Therefore, either this classification is useless in many cases or a decision must be made as to its essential features. It would seem that the most logical interpretation of their definitions of these various types is that the presence of an alkaline spreading growth on Endo's medium would indicate that the stool is "putrefactive" and that if there was no liquefaction of the Loeffler's slant and gelatin stab cultures, the flora is

TABLE 2.—CULTURAL REACTIONS OF STOOLS OF NORMAL CHILDREN AND OF THOSE WITH INTESTINAL DISTURBANCES

Character of Stool Flora	Among 18 Stools From 14 Normal* Infants Receiving Only Woman's Milk		Among 15 Stools From 11 Normal* Infants Receiving Woman's and Cow's Milk		Among 59 Stools From 36 Normal* Infants Receiving Milk and Soft Diet		Among 34 Stools From 14 Infants With Intestinal Disturbances	
	Number	Per Cent.	Number	Per Cent.	Number	Per Cent.	Number	Per Cent.
Normal type I	7	39.0	6	40.0	21	35.6	11	32.2
Normal type II	3	16.5	4	26.7	21	35.6	4	11.7
Pronounced putrefactive	0	....	2	13.3	3	5.2	8	23.6
Semiputrefactive	1	5.5	0	....	4	6.8	3	8.8
Pronounced fermentative	0	....	0	....	2	3.4	5	14.2
Semifermentative	7	39.0	3	20.0	8	13.6	3	8.8

* Normal refers to children having normal stools and no symptoms or suspicion of intestinal disorder.

"fermentative." By these criteria we would follow their classification. This would have been impossible if all the reactions of all of the mediums had been given equal weight. In recording our results in Table 2 we have used "pronounced putrefactive" and "pronounced fermentative" flora only for stools that agree absolutely with Porter, Morris and Meyer's definitions, and "semiputrefactive" and "semifermentative" for those that possess the essential qualifications of "putrefaction" and "fermentation" but vary in certain details. Stools that liquefy gelatin and the Loeffler's slant, have no spreading alkaline growth on Endo's medium and do not produce stormy fermentation in milk tubes we have classed as "normal type I" and those that in addition cause stormy fermentation, as "normal type II."

The most striking feature of Table 2 is that although the highest percentage of "putrefactive" stools was obtained from patients with intestinal disturbances, yet many such children had a "normal" flora,

while a comparatively large number of the stools from normal children were "putrefactive." Obviously, then, the presence of a "putrefactive" flora was, per se, no indication that the child required a change of diet or that he was suffering from the effects of intestinal putrefaction.

In Table 3 the cultural reactions of the thirty-four stools from fourteen children with intestinal disturbances are classified according to the clinical diagnoses of the patients. There were three children suffering from bacillary dysentery (acute febrile onset followed by the passage of bloody stools; *B. dysenteriae* (Flexner) being isolated from all of them). One of these cases was fatal. In two of these patients at the first examination the stools were "fermentative." Later while on the same diet (protein milk) we found the flora to be "putrefactive." This apparent change had no relationship to food or intestinal symptoms. The flora of the third child with dysentery was

TABLE 3.—CULTURAL REACTIONS OF STOOLS OF CHILDREN WITH DYSENTERY, ACUTE AND CHRONIC INTESTINAL INDIGESTION

Character of Stool Flora	Dysentery Cases; 6 Stools From 3 Patients		Acute Intestinal Indigestion; 16 Stools From 8 Patients		Chronic Intestinal Indigestion; 12 Stools From 3 Patients		Eight Stools From 4 Normal Children Who Had Acute Intestinal Indigestion 5-12 Months Previously	
	Number	Per Cent.	Number	Per Cent.	Number	Per Cent.	Number	Per Cent.
Normal type I	0	....	4	25.0	7	5.8	3	37.5
Normal type II	0	....	1	6.2	3	25 0	1	12.5
Pronounced putrefactive	2	33.0	5	31.0	1	8.3	1	12.5
Semiputrefactive	1	16.6	2	12.5	0	....	1	12.5
Pronounced fermentative	3	50.0	2	12.5	0	....	0	....
Semifermentative	0	....	9	12.5	1	8.3	2	2.5

"putrefactive" at the only examination which was made just before death. Although no conclusions can be drawn from three cases, it would seem that the "putrefactive" flora appeared late in the course of dysentery and might possibly be due to the fact that diarrhea produces favorable conditions for the development of "putrefactive" organisms.

The fact that only one of the twelve stools from three patients with chronic intestinal indigestion was "putrefactive" is of interest. These cases resemble the four cases which Porter, Morris and Meyer [2] associated with a "putrefactive" flora. The diets of all three patients were identical—protein milk and whole buttermilk. Their stools were examined repeatedly so that it is improbable that the flora could have been "putrefactive" without our detecting it.

It is noteworthy that the percentage of pronounced "putrefactive" and "semiputrefactive" stools of children with dysentery and of those with acute intestinal indigestion was practically the same. Although in all of this work it is impossible to prove or to disprove absolutely that

a "putrefactive" flora is of significance in intestinal disturbances, yet this similarity of flora in these two conditions would seem to indicate that the flora was the result of the diarrhea rather than vice versa; "post hoc non propter hoc."

In each case we attempted to isolate the various organisms involved. In practically all stools, regardless of the type of flora, we found members of the colon group, the *Streptococcus faecalis* and aciduric bacilli. The lack of an etiologic association of nutritional disorders with a "putrefactive" intestinal flora is quite evident when we consider the organisms that produce the cultural reactions of a "putrefactive" flora. The aerobic and anaerobic spore bearers, as well as *B. pyocyaneus* and *B. proteus,* will liquefy gelatin, the Loeffler's serum slant, and milk curds. *B. proteus* will, in addition, produce the spreading alkaline growth on Endo plates. Although these are practically the only organisms that will produce the cultural reactions which Porter, Morris and Meyer have attributed to a "putrefactive" flora, they are by no means the only putrefying or proteolytic bacteria in the stool. *B. coli, B. dysenteriae* (Flexner) and many other indol producing organisms are putrefactive and proteolytic even though they do not liquefy protein. If *B. coli* is grown in peptone water, it "putrifies" the medium with the production of indol and alkali, while in dextrose broth it "ferments" with the formation of acid and gas. Obviously, as *B. coli* is usually the predominating organism in stools, the flora is facultatively "putrefactive" or fermentative" depending on the food material available.

The aerobic spore bearers have been proved to have no relationship to intestinal conditions. Ford, Blackfan and Batchelor,[3] and later Batchelor [4] have shown that practically all varieties of aerobic spore bearers may be found in the excreta or normal infants. The types they isolated were usually the same as those present in the ingested food. The anaerobic spore bearers and more particularly the gas bacillus, *B. welchii,* have similarly been shown [5] to have no etiologic

4. Batchelor, M. D.: J. Bacteriol. **4**:23, 1919.

5. Sisson, W. R.: A Critical Review of Intestinal Bacteriology in Relation to Certain Diarrheas of Infants, Boston M. & S. J. **178**:492, 1918.
Clark, W. M., and Lubs, H. A.: A Substitute for Litmus for Use in Milk Cultures, J. Agricul. Research **10**:105, 1917.
Knox, J. H. M., and Ford, W. W.: Note on the Occurrence of Bacterium Welchii (Bacillus Aerogenes Capsulatus) in the Dejecta of Children, Johns Hopkins Hosp. Bull. **26**:27, 1915.
Simonds, J. P.: Classification of the Bacillus Welchii Group of Bacteria, J. Infct. Dis. **16**:31, 1915; also, Studies Rockefeller Inst. M. Research **2**:10, 1904.
Stitt, E. R.: Practical Bacteriology, Blood Work and Animal Parasitology, Ed. 5, Philadelphia, 1918, p. 88.

relationship to intestinal disturbances in spite of many statements[6] to the contrary. *B. pyocyaneus* has suffered the same fate.[7] *B. proteus* for many years was indicted as the cause of diarrhea in children,[8] but this organism has also been proven to be a harmless saprophyte.[9]

In Table 4 is recorded the incidence of *B. proteus* in the stools of children and of adults with dysentery and of children with simple nonspecific diarrhea.[10] If the figures for *B. proteus* in this table are compared with those of "putrefactive" and "semiputrefactive" flora in Table 2, it will be seen that with the exception of the thirteen acute cases in Birmingham, the percentage of *B. proteus* in these diarrheal diseases of children and adults it not much higher than the percentage of "putrefactive" flora in normal children.

Distaso[11] believes that *B. proteus* is always present in the intestines of adults, although it may not always be found in stool cultures. "This bacillus may sometimes be isolated from a stool which has been incubated at 37 C. for several days when cultures from the fresh feces have failed to detect it."

---

6. Kendall, A. I., and Smith, R. M.: A Rapid Presumptive Test for Diarrhea Caused by the Gas Bacillus, Boston M. & S. J. **168**:578, 1910; Diarrhea in Infants Associated with the Gas Bacillus in the Stools, Boston M. & S. J. **164**:306, 1911.

Kendall, A. I.: The Relation of Bacteria to the Etiology of Summer Diarrhea in Young Children, Boston M. & S. J. **172**:851, 1915.

Morse, J. L.: Infectious Diarrhea, Am. J. M. Sc. **149**:17, 1915.

Sylvester, P. H., and Hibben, F. H.: The Relation of the Gas Bacillus to Infectious Diarrhea and Other Digestive Disturbances in Childhood, Arch. Pediat. **32**:457, 1915.

Hill, L. W.: The Etiology and Treatment of the Diarrheal Diseases of Infancy, J. A. M. A. **72**:1653, 1919.

7. Davison, W. C.: Bacillary Dysentery in Children, Johns Hopkins Hosp. Bull. **31**:225, 1920.

7. Lartigen and Adami: B. Pyocyaneus as the Cause of Dysentery in Canada, Castellani, A., and Chalmers, A. J., Manual of Tropical Medicine, Ed. 3, Lond., 1919, Bailliere, Tindall & Cox, p. 1841.

Calmette: Note sur la presence du bacille pyocyanique dans le sang et l'intestin de dysenteriques en Cochin-Chine, Arch. de méd. Navale **60**: 207, 1892.

8. Booker, W. D.: A Bacteriological and Anatomical Study of the Summer Diarrheas of Infants, Johns Hopkins Hosp. Rep. **6**:159, 1897; Cases of Ulcerative Catarrhal Dysentery, Tr. Am. Ped. Assn. **3**:192, 1891.

Tsiklinsky, Mlle.: Contribution a l'etiologie des diarrhees des nourrissons, Ann. de l'Inst. Pasteur **31**:517, 1917.

Fiore, G.: Agglutination of Proteus X in Various Children's Diseases, Rev. di Clin. Pediat. **17**:598, 1919.

9. Tenbroeck, C., and Norbury, F. G.: The Presence of B. Dysenteriae, B. Proteus Vulgaris, B. Welchii, and Morgan's Bacillus No. 1 in the Stools of Cases of Infectious Diarrhea, Boston M. & S. J. **173**:280, 1915.

Tenbroeck, C., and Norbury, F. G.: B. Dysenteriae as a Cause of Infectious Diarrhea in Infants, Boston M. & S. J. **174**:785, 1916.

10. Davison, W. C.: The Aerobic Flora of Dysentery Stools in Adults and Children, Tr. Soc. Am. Bacteriologists, 1919; Abstr. Bacteriol. **4**:15, 1920.

11. Distaso, A.: The Change of a Normal Stool Flora to a Typical Flora of Constipation in Vitro, Zentralbl. f. Bakteriol. **75**:507, 1915.

In other words, all of the organisms that produce the cultural reactions of a "putrefactive" stool have been reported as frequently existing in the excreta of normal individuals.

Our analyses of the organisms isolated from stools giving the reactions of a "fermentative" flora revealed the absence of aerobic spore bearers, *B. proteus* and *B. pyocyaneus*. The difference in the reactions of stools with "fermentative" and "putrefactive" flora appeared to be due to the protein liquefying organisms

The only feature common to children with dysentery and with acute intestinal indigestion is diarrhea. Their other symptoms are different; the former are febrile and have blood in their stools while the latter often have a normal temperature and rarely have blood in their stools. In the former we know [12] that *B. dysenteriae* (Flexner) or (Shiga) produces the diarrhea and intestinal symptoms. We know also, that the aerobic and anaerobic spore bearers, as well as *B. proteus* and *B. pyocyaneus,* which are frequently associated with *B. dysenteriae* in the stools of dysentery patients, have no etiologic connection with this

12. Flexner, S., and Holt, L. E.: Bacteriological and Clinical Studies of the Diarrheal Diseases of Infancy with Reference to the B. Dysenteriae (Shiga), Studies Rockefeller Inst. M. Research **1**:202, 1904.

Marshall, W. E.: Case of Acute Sporadic Dysentery in a Child Associated with the Presence of B. Dysenteriae (Flexner), J. Roy. Army Med. Corps, Lond. **12**:556, 1909.

Bainbridge, F. A., and Dudfield, R.: An Outbreak of Dysentery, J. Hygiene **11**:356, 1911.

Ohno, quoted by Shiga, K.: Mod. Med. Ed. 2 (Osler and McCrae), Philadelphia and New York **1**:770, 771, 776, 1913.

Torrey, J. C.: A Comparative Study of Dysentery and Dysentery-Like Organisms, Pt. I, Bacilli Producing a Typical Reaction in Litmus Milk; Pt. II, Dysentery-Like Organisms Which Produce an Atypical Reaction in Litmus Milk and Should Probably Be Included Within the Group of Pseudodysentery Bacilli, J. Exper. Med. **7**:365, 385, 1905.

Leiner, K.: Ueber bazilläre Dysenterie, speziell im Kindesalter, Wien. med. Wchnschr. **17**:738, 1904.

Cuervo, A. M.: Bacillary Dysentery, Rev. med. del Uruguay **22**:117, 1919.

Hastings, Pease, Shaw and Jehle: In Pfaundler, M., and Schlossmann, A., The Diseases of Children, Eng. Transl. Ed. by H. L. K. Shaw and E. L. La Fetra, Philadelphia and London, 1908, J. B. Lippincott Co. **3**:298.

Zahorsky, J.: Dysenteriae in Infants, St. Louis Cour. Med. **27**: 1902.

Kendall, A. I.: Observations on the Etiology of Severe Summer Diarrheas of Bacterial Causation, Boston M. & S. J. **169**:754, 1913.

Penfold, W. J.: Two Cases of Dysentery in Children Due to B. Dysenteriae of Flexner Type, Brit. M. J. **2**:722, 1915.

Slawik, E.: Serologische und klinische Beiträge zur Kenntniss der Dysenterie der Säuglinge, Jahrb. f. Kinderh. **90**:119, 1919.

Wollstein, M.: The Dysentery Bacillus in a Series of Cases of Infantile Diarrheas, J. M. Research **10**:11-20, 1903.

Bauer, J., Ellenbeck, Fromme, Siegel: Dysentery Among Young Children, Arch. f. Kinderh. (A. Baginsky Festschrift) **60**: **61**: 1913.

Keuper, E.: Dysentery Epidemic in Young Children, München. med. Wchnschr. **61**:1914.

diarrhea. We know that these former organisms produce the cultural reactions of a "putrefactive" flora. Surely, it is not illogical to conclude that a "putrefactive" flora in children with dysentery is not the cause of the intestinal disturbance. There is no more evidence to prove that a "putrefactive" flora is the cause of the diarrhea in children with acute intestinal indigestion than there is in children with dysentery. It is more probable that in acute intestinal indigestion we are dealing with diarrhea which is produced by some cause so far undetermined, possibly chemical and not bacteriologic and as a result of the diarrhea, conditions are more favorable for the growth of organisms which give the cultural reactions characteristic of a "putrefactive" flora. That diarrhea alone may increase the relative proportions of certain bacteria in stool cultures seems probable from the fact that the nonlactose, nonliquefying bacilli are more numerous in the stools of children with diarrhea than in normal children but yet occur sufficiently frequently in normal individuals to preclude their being the cause of diarrhea.[13]

With intestinal diseases of known bacterial origin, such as bacillary dysentery and typhoid fever, there are anatomic evidences of the action of these organisms and their toxins. On the other hand, in the intestines of patients dying of acute or chronic intestinal indigestion, there may be no evidence of pathologic lesions. The mucosa may, perhaps, be slightly hyperemic or the intestinal wall may be thinned, but these features are probably the result of increased peristalsis, distention and amaciation. If intestinal indigestion were the result of the absorption of bacterial toxins from the intestines, it is likely that

13. Lewis, C. J.: Bacteriology of Normal and Diarrheal Stools of Children in Birmingham, England, 1910, Loc. Gov. Board Reports, Med. Suppl., 1910-1911, Appendix B, No. 2, 314; Bacteriology of Normal and Diarrheal Stools of Children in Birmingham, England, 1911, Loc. Gov. Board Reports, Med. Suppl., 1911-1912, Appendix B, No. 2, 265.

Orr, T.: Bacteriology of Normal and Diarrheal Stools of Children in Shrewsbury, England, 1910, Loc. Gov. Board Reports, Med. Suppl. 1910-1911, Appendix B, No. 4, 367.

Ross, S. M.: Bacteriology of Normal and Diarrheal Stools of Children in Manchester, England, 1910-1911, Loc. Gov. Board Reports, Med. Suppl., 1910-1911, Appendix B, No. 3, 347.

O'Brien, R. A.: Bacteriology of Normal and Diarrheal Stools of Children in London, England, 1910, Loc. Gov. Board Reports, Med. Suppl., 1910-1911, Appendix B, No. 4, 367.

Alexander, D. M.: Bacteriology of Normal and Diarrheal Stools of Children in Liverpool, England, 1911, Loc. Gov. Board Reports, Med. Suppl., 1911-1912, Appendix B, No. 3, 288.

Alexander, D. M.: Bacteriology of Normal and Diarrheal Stools of Children in Liverpool, England, 1912, Loc. Gov. Board Reports, Med. Suppl., 1912-1913, Appendix B, No. 4, 384.

Morgan, H. de R., and Ledingham, J. C. G.: The Bacteriology of Summer Diarrhea, Proc. Roy. Soc. Med., Lond. **2**: Epidemiol. Sec., 133, 1908.

Morgan, H. de R.: Upon the Bacteriology of the Summer Diarrhea of Infants, Brit. M. J. **1**:908, 1906; **2**:16, 1907; J. Hygiene **11**:1, 1911.

some demonstrable lesion such as the pseudomembrane formation of diphtheria or the ulcerations of bacillary dysentery and typhoid fever would be present.

The majority of the diarrheal stools of patients with intestinal indigestion are acid in reaction. Most of these cases are aggravated by increasing the carbohydrate intake and care usually cured by restricting it. Therefore, it would seem reasonable to suppose that many instances of intestinal indigestion might primarily be a failure on the part of the small intestine to handle carbohydrate. The sugar would then pass more or less unchanged to the lower ileum and colon where it would be "fermented" by *B. coli* and other organisms of the intestinal flora into butyric, lactic and other organic acids. The irritation of the intestinal mucosa by these acids would result in increased peristalsis.

TABLE 4.—THE INCIDENCE OF B. PROTEUS IN INTESTINAL CONDITIONS

Type of Case	Condition of Specimen	Number of Patients	Number of Patients Harboring B. proteus	Percentage Positive for B. proteus
Acute bacillary dysentery in children (Birmingham, Ala.) [9]	Satisfactory*	13	7	54.0
Acute bacillary dysentery in children (Birmingham, Ala.) [9]	Unsatisfactory†	12	2	16.0
Acute bacillary dysentery in children (Baltimore, Md.) [9]	Satisfactory	31	5	16.0
Convalescent bacillary dysentery in children (Birmingham, Ala.) [9]	Unsatisfactory	15	2	13.0
Acute bacillary dysentery in adults (A. E. F., France) [13]	Satisfactory	182	26	14.0
Simple noninfectious diarrhea in children (Baltimore, Md.) [9]	Satisfactory	51	3	6.0

Repeated cultures were made from the majority of patients.
* Satisfactory refers to cultures made within 6 hours after the passage of the stool.
† Unsatisfactory denotes specimens cultured more than 6 hours after passage.

That the products of the "fermentation" of unabsorbed carbohydrate may be the cause of diarrhea would seem to be indicated by the fact that children who have numerous loose stools when given carbohydrate in the form of cane sugar or lactose, may not have diarrhea when fed cereals, such as farina. It is probable that dextrose and maltose are liberated gradually from the slowly digesting cereal and starch. The absorptive power of the small intestine, even though diminished, may keep pace with these small amounts of free dextrose and maltose and thus prevent their passing into the ileum and colon. Cane sugar or lactose in excess of the amounts that can be absorbed, even in normal individuals, will frequently produce loose stools. The "fermentation" of unabsorbed carbohydrate and the consequent gas production undoubtedly play a part in abdominal distention for restricting the intake of sugar frequently relieves it.

It is conceivable that there may also be instances of intestinal disturbances in which protein digestion and assimilation are delayed. The intestinal flora would then "putrefy" the unabsorbed protein into proteinogenous amins and indol, skatol or other phenol derivatives and produce foul smelling stools. It is not at all clear, whether these products of "putrefaction" may be absorbed and give rise to a systemic reaction in the absence of any pre-existing injury to the intestinal wall. However, in both intestinal "fermentation" and putrefaction," the action of the intestinal flora is usually facultative and the predominence of either process probably depends on the carbohydrate or protein pabulum furnished by physiologic digestive and absorptive disturbances in the stomach or small intestine. For that reason, it would appear to be inaccurate to speak of a "putrefactive" or a "fermentative" flora.

TABLE 5.—RELATION OF VARIOUS DIETS TO THE INCIDENCE OF A "PUTREFACTIVE" FLORA

	Children With Intestinal Disturbances				Normal Children			
	Protein Milk	Butter-milk	Cow's milk Formula	Soft Diet	Protein Milk	Butter-milk	Cow's Milk Formula	Soft Diet
Number of stools from children on each diet.....	21	10	5	1	1	0	56	2
Number of putrefactive flora in children on each diet.....	6	2	2	1	0	0	8	0
Percentage of putrefactive flora in children on each diet.....	28	20	40	100	0	0	14	0

The last column of Table 3 is interesting for the fact that it appears to refute the statement of Porter, Morris and Meyer that a "return of these children to normal health is coincident with a regression of the intestinal flora toward predominately fermentative types and a later swing to balance between the two types." These four children, who had acute intestinal indigestion from five to twelve months previously, had no symptoms or suspicion of intestinal disturbances when we cultured their stools, yet one child had a "putrefactive" and "semi-putrefactive" flora. Either children may return to normal health and still harbor "putrefactive" organisms or a "putrefactive" flora is not an indication of intestinal disturbances.

The statement that a high carbohydrate diet may cause a "putrefactive" flora to become "fermentative" does not seem to be substantiated by Table 5. The children with intestinal disturbances who were on a relatively high carbohydrate diet with cow's milk had a higher incidence of "putrefactive" stools than those on a low carbohydrate diet of protein milk and buttermilk.

The fallacy of regarding a "putrefactive" flora as an indication for increasing the carbohydrate in the diet is shown by the fact that some of the patients with chronic intestinal indigestion who had a "putrefactive" flora were made definitely worse by giving them more sugar. The frequency of the stools and the degree of distention were increased and the weight decreased.

That a "putrefactive" flora is not a criterion for changing the diet, and that high carbohydrate feeding may fail to cause a "putrefactive" flora to become "fermentative," are evident from the two cases cited herewith. The flora apparently changed from "putrefactive" to "normal" and back again without any change in diet. At another time, following a relatively high carbohydrate diet, the flora regressed from "normal" to "putrefactive."

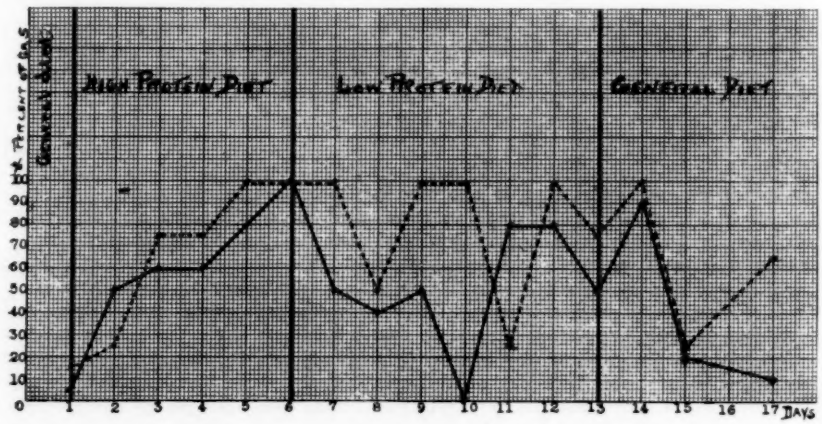

Fig. 1.—Effect of high and low protein diets on the percentage of gas produced in lactose peptone water and milk, inoculated with undiluted feces. The proportions of gram-negative bacilli and gram-positive cocci in smears of the growth of these cultures did not appear to vary from day to day. The continuous line indicates the percentage of gas produced in lactose peptone water (Durham fermentation tubes) inoculated with undiluted feces (seventy-two hour cultures). The broken line indicates the percentage of gas produced in milk (Smith fermentation tubes) inoculated with undiluted feces (seventy-two hour cultures).

Case 1.—An infant with intestinal indigestion, who was receiving a diet of protein milk and who was having from four to five soft stools per day, had a "putrefactive" flora at the first examination. Two days later, while on the same diet, the flora was "normal." The following day, and also two and a half months later, the diet being unchanged, the flora was "putrefactive." Whole buttermilk was then substituted for protein milk and after an interval of two weeks, and again one week later, the flora was "normal." The carbohydrates were increased still further and the child was fed whole milk, cane sugar, farina and broth. A "putrefactive" flora was found when the stools were cultured two weeks later.

CASE 2.—An infant with intestinal indigestion, receiving a diet of protein milk, had a "putrefactive" stool flora at the first examination. Two weeks and five weeks later, while on the same diet, the flora was "normal."

We studied by these cultural methods the influence of a high and low protein diet on the stools of a normal adult. The type of stool flora was "normal Type II" throughout the seventeen days of the experiment. No intestinal or other symptoms were noted on these different diets. The health was excellent throughout, and with exception of complaints in regard to the lack of taste of the arrow root mixtures, the food was well borne, though not enjoyed. The only deviation from the cultural findings on a general diet to be noted during the five days of a high protein diet[14] was an increase in the gas

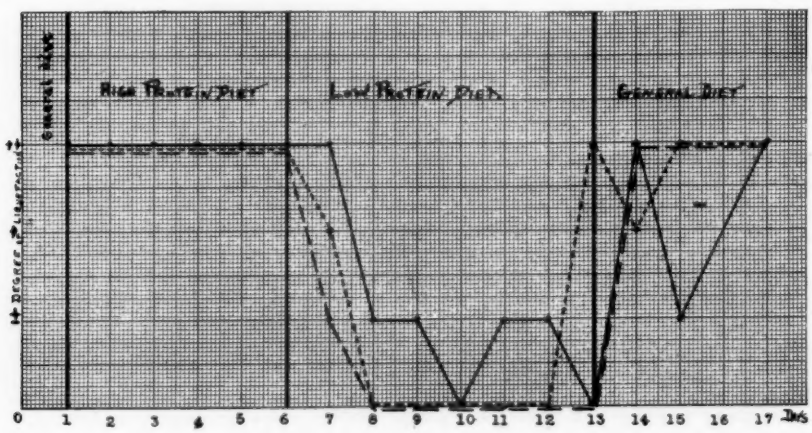

Fig. 2.—Effect of high and low protein diets on the aerobic spores bearing bacilli in an adult's stools, as shown by the liquefaction of gelatin and of Loeffler's serum slant stool cultures and by smears of the growth on the latter cultures. The continuous line indicates the variations in the liquefaction of gelatin tubes inoculated with undiluted feces (after twenty-eight days at room temperature). The broken line (short dashes) indicates the variations in the liquefaction of Loeffler's serum slant cultures inoculated with undiluted feces (seventy-two hour cultures). The broken line—long dashes—indicates the variations in the numbers of aerobic spore bearing bacilli in smears of the growth on the Loeffler's serum slant cultures.

production in lactose peptone water and brom-cresol-purple milk. We could detect no obvious difference in the number of gram-negative bacilli and gram-positive cocci in smears of the growth of these cultures

14. High protein diet: daily ration (from second to sixth day, inclusive), milk, 500 c.c.; 16 per cent. cream, 300 c.c.; 9 eggs, Horlick's malted milk, 200 gm.; sugar, 20 gm.; salt, 6 gm.; distilled water, 1,000 c.c.

(Fig. 1). When the diet was changed to one low in protein [15] the gas production in lactose and milk decreased but great variations occurred.[16] The most striking features during this period of low protein diet were the reduction and then disappearance of liquefaction of gelatin and the Loeffler's serum slant (Fig. 2). Smears of the growth on the Loeffler's serum slants demonstrated that the aerobic spore bearers disappeared pari passu with the evidences of liquefaction. At first glance it would appear that a low protein diet as Porter, Morris and Meyer [2] claim for children will reduce the liquefying "putrefactive" organisms. However, the more probable explanation for this sudden change is to be found in the fact that this low protein diet contained no raw milk after the first day, and was composed largely of cooked material, so that few if any viable aerobic spore bearers which would cause liquefaction were ingested. As soon as a general diet was resumed, the aerobic spore bearers and the liquefaction of mediums reappeared. This explanation may also be applied to the therapeutic results of Porter, Morris and Meyer. When they prescribed high carbohydrate diets they restricted or eliminated milk, which even after pasteurization contains many viable "putrefying" spore bearing bacilli. Naturally, as the intake of "putrefying" organisms was reduced, there were less in the stool cultures.

The changes in the cultural reactions of this adult's stools on Endo's media, deep agar tubes (spore material) and deep milk tubes (spore material) on these different diets were insignificant.

CONCLUSIONS

1. The so-called "putrefactive" and "fermentative" types of stool flora occur too frequently in normal children to be of diagnostic or therapeutic significance in patients with nutritional disorders.

2. A "putrefactive" flora is without etiologic importance in the stools of patients with dysentery and probably also in cases of acute and chronic intestinal indigestion.

3. The organisms capable of producing the cultural reactions ascribed to the "putrefactive" type of stool flora are harmless saprophytes.

4. The influence of diet on the incidence of a "putrefactive" flora is not striking.

---

15. Low protein diet: (seventh day): Starch, 50 gm.; sugar, 175 gm.; 32 per cent. cream, 325 c.c.; distilled water, 1,000 c.c.

Low protein diet: daily ration (eighth, ninth and tenth days), taffy, 100 gm.; potatoes, 2,000 gm.; 16 per cent. cream, 300 c.c.; butter, 30 gm.; salt, 10 gm. cooked together; distilled water, 1,000 c.c.

Low protein diet (eleventh day): arrow root starch, 300 gm.; butter, 75 gm.; cooked together. Karo corn syrup, 50 gm.; distilled water, 1,500 c.c.

Low protein diet: daily ration (twelfth and thirteenth days), arrow root starch, 150 gm.; butter, 35 gm.; sugar, 35 gm. cooked together. Distilled water, 1,500 c.c.

16. Torrey, J. C.: J. Infect. Dis. **16**:72, 1915; J. M. Research **39**:415, 1919. Kerr, MacNeal and Latzer: J. Infect. Dis. **6**:123, 571, 1909.

CONGENITAL HEART BLOCK*

PAUL D. WHITE, M.D. and RICHARD S. EUSTIS, M.D.
BOSTON
and
WILLIAM J. KERR, M.D.
SAN FRANCISCO

Congenital heart block is very rare. Its discovery before birth with electrocardiographic proof on the fourth day after birth is unique. Recently, Carter and Howland [1] reviewed eight cases of congenital heart block proven by graphic records, seven recorded in the literature and one of their own. We desire to add three cases to this group, two cases from the literature, Gorter's [2] and Smith's,[3] and one case of our own which was discovered before birth. We report, in addition, a probable case of congenital heart block. The accompanying table records the important features of these twelve cases proven by graphic records.[4]

Eyster and Middleton [7] recently published a paper summarizing twenty-one cases of heart block in children under 14 years of age, twenty from the literature and one of their own. Seven of the cases they considered to be congenital and two others possibly congenital. Their own case, a boy, aged 2 years, showed a two-to-one heart block associated with an acute infection in the nose and throat. It is quite likely that this was a case of congenital heart block also, but because of the coincident infection it is by no means sure. Four of the nine cases of probable congenital heart block tabulated by Eyster

* Received for publication, April 18, 1921.

* From the Boston Lying-In and Massachusetts General Hospitals, and the University Hospital, San Francisco.

1. Carter, E. P. and Howland, J.: Bull. Johns Hopkins Hosp. **31**:351, 1920.
2. Gorter, E.: Nederlandsch. Maandschr. v. Verl. en Vr. en voor Kinderg., 1919.
3. Smith, S. C.: J. A. M. A. **76**:17 (Jan. 1) 1921.
4. A recent case of congenital heart disease (pulmonary stenosis) with auriculoventricular dissociation has been reported by F. A. Willius.[5] This is not, however, a case of congenital heart block. The dissociation is due to ventricular escape resulting from the sino-auricular bradycardia and high *a-v* nodal irritability (auricular rate of 61 and ventricular rate of 69). Occasionally, there is a normal auriculoventricular sequence, at the time of the short diastole. The slow auricular rate is due to the abnormal position of the auricular pacemaker, as indicated by the inverted P wave of the electrocardiogram. A discussion of auriculoventricular dissociation resulting from ventricular escape has been published by one of us.[6]
5. Boston M. & S. J. **184**:64, 1921.
6. White, P. D., Arch. Int. Med. **18**:244 (Aug.) 1916.
7. Eyster, J. A. E. and Middleton, W. S.: Am. J. Dis. Child. **19**:131 (Feb.) 1920.

and Middleton had no proof of the condition by graphic record. Undoubtedly, however, some were actually such cases. Unproven cases have doubtless been observed before 1908. If the condition were more often looked for, it would probably be found more frequently.

Congenital heart block is almost always associated with congenital malformation of the heart—patency in the interventricular septum. The close proximity of the atrioventricular bundle to the upper part of the interventricular septum, which is the last part of the septum to develop, gives a clue to the defective conduction by the bundle. Defective development of this part of the junctional tissues and septum is the probable reason for the combination of findings, although the literature is still barren so far as actual histologic study of this area of the heart in congenital heart block is concerned. Of the eleven proven cases of congenital heart block, six showed signs of patency in the interventricular septum, four were doubtful, and one was said to show a communication between the aorta and pulmonary artery just above the aortic valves (see table). Our probable case was doubtful as to the presence of congenital malformation of the heart. Cardiac enlargement was marked in four cases, slight in six and not noted in one. Three cases showed slight cyanosis, the others none. No case showed any clubbing of the fingers. Four cases gave a history of one or more syncopal attacks. Our probable case showed moderate enlargement, no cyanosis, clubbing of the fingers or syncopal attacks.

The ages at which the heart block was proved varied from 4 days, our younger case, to 23 years, Van der Heuvel's case.[8] The pulse was noticed to be slow or irregular as early as six hours after birth in Gorter's case and eight hours before birth in ours. The sexes are evenly represented, five males and six females. Our probable case was in a male.

Hereditary heart block was reported by Fulton, Judson, and Norris.[9] Their paper is entitled "Congenital Heart Block Occurring in a Father and Two Children, One an Infant." This is the only such reference in the literature and it is incorrect. The published tracings of the father and older child do not show heart block. In the case of the father "v" and "h" waves were mistaken for "blocked a" waves in the jugular pulse and in the older child's tracing the "v" waves were mistaken for "a" waves. Both tracings are normal. The younger child, 22 months old, did show complete heart block with patency in the interventricular septum. The hereditary nature of congenital heart block is still to be proved.

---

8. Van der Heuvel, G. C. J.: Proefschr aan de Rijks Univers. Groningen, 1908.

9. Fulton, Z. M. K., Judson, C. F., and Norris, G. W.: Am. J. M. Sc. **140**: 339, 1910.

Cases of Congenital Heart Block

Case No.	Date	Author	Reference	Sex	Age When Proven	Age When Slow Pulse First Noticed	Congenital Malformation	Cardiac Enlargement	Grade of A-V Block	Slowest Ventricular Rate	Cyanosis	Syncopal Attacks	Other Observations
1	1908	Van der Heuvel, G. C. T.	Proefschr. aan de Rijks Univers., Groningen, 1908	F	23 yrs.	15 yrs.	Patency in interventricular septum	Marked	Complete	34	Slight	Present, first at age of 2 years	
2	1910	Fulton, Z. M. K., Judson, C. F., and Norris, G. W.	Am. J. M. Sc. **140:**339, 1910	M	22 mos.	7 days	Patency in interventricular septum	Slight	Complete	42	Absent	None	Father and older child had normal rhythm and not heart block as reported
3	1915	d'Espine, Ad. and Mlle. Cottin	Bull. de l'Acad. de Méd. **74:**292, 1915	M	8 yrs.	8 yrs.	?	Slight	Complete	20	Absent	One	
4	1915	Whipham, T. R.	Brit. J. Child. Dis. **12:** 321, 1915	F	18 mos.	18 mos.	Patency in interventricular septum	Slight	Partial 2:1	56	Absent	None	
5	1915	Whipham, T. R.	Brit. J. Child. Dis. **12:** 321, 1915	F	12 yrs.	6 yrs.	Patency in interventricular septum	Marked	Complete	40	Absent	None	
6	1918	Bass, M. H.	J. A. M. A. **70:**287 (Feb. 2), 1918	M	15 yrs.	13 yrs.	?	Slight	2:1 and complete	37	Absent	None	
7*	1919	Gorter, E.	Nederlandsch. Maandsch. v. Verl. en Vr. en voor Kinderg. 1919	M	6 mos.	6 hrs.	?	?	Complete	72	Slight	None	
8	1920	Rosenson, Wm.	Arch. Pediat. **37 :** 103. 1920	F	10 yrs.	8 yrs.	Communication between aorta and pulmonary artery just above aortic valve ?	Marked	Complete	44	Absent	None	
9	1920	Carter, E. P., and Howland, J.	Bull. Johns Hopkins Hosp., **31:**351, 1920	F	3 yrs.	3 yrs.	Patency in interventricular septum	Slight	Complete	37	Absent	One attack at age of 4 years	
10*†	1921	Smith, S. C.	J. A. M. A. **76:**17 (Jan. 1) 1921	M	20 yrs.	20 yrs.	?	Slight	Complete	43	Absent	Present, first at age of 3 years	
11*	1921	White, P. D., Eustis, R. S., and Kerr, W. J.	Am. J. Dis. Child. **21:** 1921	F	4 days	Before birth	Patency in interventricular septum	Marked	Partial 2:1 and less	70	Slight	None	Mongolian idiocy; right preponderance (marked) by electrocardiogram
12* (Probable)	1921	White, P. D., Eustis, R. S., and Kerr, W. J.	Am. J. D.s. Child. **21:** 1921	M	6 yrs.	5½ yrs.	?	Moderate	Complete	46	Slight on exercise	None	

* New cases.

† The absence of infections of any importance and the occurrence of syncopal attacks between the ages of 3 years and 9 years are etiologic evidence in this case.

Congenital heart block may be either partial or complete. Eight of the eleven cases collected here showed complete block, two showed partial block of from two to one grade or less, and one showed both complete and partial (two to one) block. Our probable case (case 12) showed complete block. Ventricular rates in the cases showing complete block ranged from 20 to 72 per minute, usually from 30 to 50. The slowest rates of the partial (two to one) block cases were 56 and 70, respectively.

Finally, the association of the congenital heart condition with mongolian idiocy in our proven case is of interest though not noted in the other cases of congenital heart block. The combination, however, of idiocy with congenital heart disease is a recognized one and is mentioned in the literature.[10]

REPORT OF CASES

Case 1 (Case 11 in Table).—M. W., female, Jewish, 4 days old, seventh child, was born at full term without difficulty. Mother, father and six other children in good health. Mother's Wassermann reaction was negative. Infant was breast fed.

Observation made Aug. 3, 1920 by Dr. Thomas R. Goethals, intern at Boston Lying-In Hospital, eight hours before birth, revealed a very irregular fetal heart rate. After an uneventful delivery, the pulse remained unusual, and on the second day after birth, examination showed now a regular rate of 80, now a bigeminy at about 105, a trigeminy at 120 or a rapid regular rate of 160. Premature beats were not heard, and a presumptive diagnosis of heart block was made. There were no murmurs at this time.

The baby weighed 7½ pounds at birth. At first it was rather cyanotic and became much more so on crying, but the cyanosis was no longer noticeable on the second day after birth. The facies resembled that of a mongolian idiot.

At four days of age the child was brought to the Massachusetts General Hospital where electrocardiograms showed partial block—two to one, three to one, and lesser grades (Figs. 1 and 2). There was evidence of pronounced right ventricular preponderance (125 degrees by Einthoven's triangle and —22 by White's index).

Sept. 7, 1920, the baby, now five weeks old, was brought to the hospital again. Mongolian idiocy was now very evident. There was no clubbing of the fingers, but there was definite slight cyanosis of mucous membranes and finger tips. A blowing systolic murmur had developed; it was heard all over the precordia but was loudest at the base at the left of the sternum; there was no diastolic murmur. Electrocardiograms showed normal sinoauricular rhythm with a rate of 150 but absolutely no block—the P-R interval being about 0.11 seconds. Right ventricular preponderance continued with index of —20 to —21.

A third examination made Oct. 21, 1920 showed by electrocardiogram normal rhythm, no delay in A-V conduction, a ventricular rate of from 160 to 170 and a persistence of right ventricular preponderance. The baby, now definitely seen to be a congenital idiot, was 11 weeks old. It was undernourished and apathetic. There was no cyanosis and no clubbing of the fingers. The systolic murmur

10. Garrod, A. E.: Tr. Clin. Soc. Lond. **31**:316, 1898. Hill, W. B.: Quart. J. M. **2**:49, 1908. Langmead, F.: Rep. Soc. Study Dis. Child., Lond. **8**:276, 1908. Carpenter, G.: Rep. Soc. Study Dis. Child., Lond. **8**:278, 1908. Weber, F. P.: Brit. J. Child. Dis. **14**:269, 1917.

over the precordia was heard much less distinctly than in September. Fluoroscopic examination showed a very large globular heart confirmed by roentgenogram.

Jan. 1, 1921, a visit was made to the home of the baby because the mother feared to bring it to the hospital on account of the cold. The baby was not doing well, sleeping most of the time. Its idiocy was marked. It weighed 10 pounds at about 5 months of age. The heart was large and showed again intermittent pulsations, the grade of block varying from two to one, to four to three, and one to one. The pulse rate ranged from 70 to 140. The systolic murmur was heard loudest at the left border of the sternum as before. The pulmonic second sound was accentuated. There was no diastolic murmur.

April 5, 1921, at the age of 8 months, the baby was seen again. The mother stated that the baby had been sickly all winter with frequent colds. On physical examination, there was evident a typical mongolian facies and rachitis, as shown by craniotabes, Harrison's groove and rosary. The tongue was dry, protruding, but not fissured. The heart showed a diffuse apex impulse outside

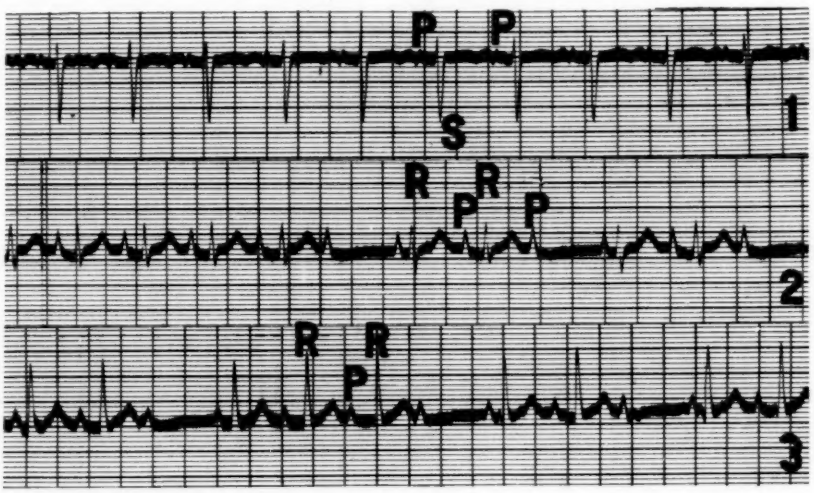

Fig. 1.—Electrocardiogram of M. W. taken Aug. 7, 1920 at the age of 4 days, showing partial heart block. Upper record is Lead I, middle is Lead II and lower is Lead III. Note the absence of dropped beats in Lead I, and the presence of right ventricular preponderance. Auricular rate = 130. P = auricular complex, R and S = ventricular complexes. Abscissa = 0.2 second. Ordinate = 10^{-4} volt.

the nipple line. The first sound at the apex was reduplicated with well marked systolic murmur following. The pulmonic second sound was accentuated. A loud systolic murmur and fainter early diastolic murmur were heard along the left border of the sternum, especially in the second and third interspaces. There were no thrills. The rate was rapid (110) and the rhythm normal. There was no cyanosis; little or no clubbing of the fingers; slight umbilical hernia, No enlargement of the epiphyses.

The electrocardiogram made on April 5 showed normal rhythm at a rate of 120, short P-R interval, split R wave in Lead II and right ventricular preponderance (less marked than before—now index = —10).

The teleroentgenogram ("6 foot" roentgen-ray plate) made April 5, showed the following shadow-border measurements:

To the right of midline, 2.8 cm.; to left of midline, 5.0 cm.; transverse diameter, 7.8 cm.; length, 7.2 cm.; internal diameter of chest, 12.5 cm.; cardiothoracic index, 7.8:12.5. No abnormal prominence in region of pulmonary artery but heart is of "sabot" shape.

Comment.—It is evident from the last three examinations (at the ages of 2½, 5 and 8 months) that the partial heart block is of variable occurrence—possibly paroxysmal. It is likely from the last examination that there is patency of the ductus arteriosus (diastolic murmur) in addition to the ventricular septal defect. The heart is big. Mongolian idiocy is well established.

CASE 2 (Case 12 in Table).—April 14, 1920. L. C., male, aged 6 years; referred by Dr. McP. of Fresno.

Family History.—Father and mother are living and well. Mother had one miscarriage at seven months and also a nephrectomy two years ago for

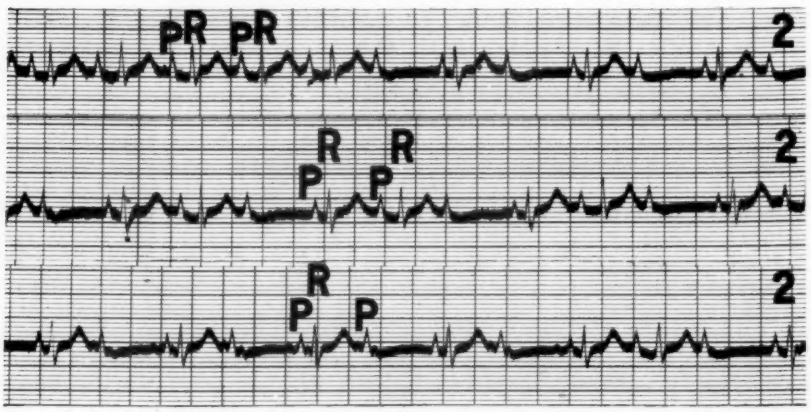

Fig. 2.—Electrocardiogram of M. W. taken Aug. 7, 1920, showing three records of Lead II. Normal rhythm which is present at the beginning of the first strip changes to two to one heart block. In the second strip three to two block is present and in the lowest strip two to one block occurs. Note the varying P-R intervals. P = auricular complex. R = Ventricular complex. Abscissa = 0.2 second. Ordinate = 10^{-4} volt.

tuberculosis of the kidney. Wassermann of both parents is negative. One sister is living and well, aged 5 years.

Past History.—Full term baby; normal, apparently. Breast fed for four months. Development was normal. In July, 1919, an adenotonsillectomy was done. The child suffered a bronchopneumonia in February, 1920. There is no history of ear disease, nor is there a history of a rash in infancy or later. The bowels are regular. Urination is normal. Sleep and appetite are good.

Present Complaint.—The child was referred by Dr. McP. with the following notes: "Child first seen in January, 1920. History negative, except that there had been several severe attacks of tonsillitis. In July, 1919, at the time of the operation on his throat, the physician in charge recorded a negative heart examination. Since that time, however, the boy has not gained in weight; has taken cold easily; is very nervous and weak. The mother had never observed

fever or slow pulse, but she had noticed cyanosis and dyspnea on exercise. In January, 1920, a subacute rhinitis occurred with nasal discharge and a temperature of 99 F. The lungs were clear. The heart was enlarged downward and to the left; the rhythm labored, but regular; rate 48 per minute; visible systole over the precordium; marked carotid pulse. The cervical, inguinal and epitrochlear glands were enlarged and indurated. The blood pressure was 90/65. Hemoglobin 70 per cent. Urine normal. Von Pirquet test negative. Luetin test markedly positive. The temperature varied from 99 to 100 F. until February 5, when there was an intercurrent bronchopneumonia of a week's duration. It was thought that the child had possible congenital syphilis, and he was treated with mercurial rubs, and four doses of neo-arsphenamin. His glands seemed to diminish somewhat in size, but the pulse rate remained the same."

Physical Examination.—Heart: Maximal impulse is palpable in the fifth space, one-fourth inch inside the nipple line, and in the sixth space almost to the nipple line; also palpable along the fifth space to the sternum. It is visible in both spaces with a systolic retraction; in the epigastric angle the apex beat is slow, forceful and heaving; no palpable thrill. Percussion dulness to left of midsternum found in fourth space, 5 cm.; in fifth space, 7 cm. The

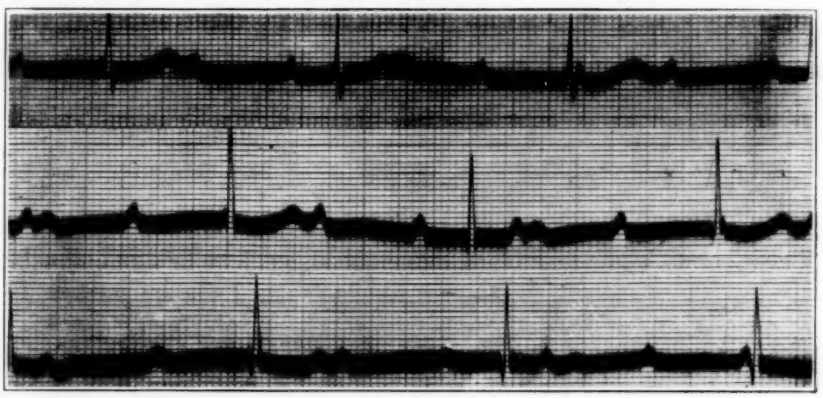

Fig. 3.—Electrocardiogram (leads I, II and III), of L. C. taken April 14, 1920, showing complete heart block. Auricular rate, 120; ventricular rate, 45. Abscissa = 0.04 second. Ordinate = 10^{-4} volt. Electrocardiogram of L. C. taken Dec. 21, 1920, showed similar findings.

dulness is increased to the right and slightly to the left. There is dulness to the right of the sternum in the second and third spaces. Pulse rate is 46 in the erect position; 60 after active exercise (jumping). No murmurs before exercise. After exercise, at the apex is heard a loud, systolic murmur; the second sound at the pulmonic area is reduplicated; there is no evidence of a presystolic murmur. A systolic murmur is heard, loud and wheezing in character, over the pulmonic area. It is not transmitted, unless the systolic murmur heard at the aortic area is a transmitted one. There are no dropped beats at the wrist.

The liver and spleen are not palpable; there is no enlargement of the veins of the neck; there is no clubbing of the fingers or toes.

Fluoroscopic examination of the chest shows an enlarged rounded heart centrally located. Ventricular rate is slower than auricular rate.

April 14, 1920, an electrocardiogram showed complete heart block with ventricular rate of 45 and auricular rate of 120 (Fig. 3). Dec. 21, 1920, an electrocardiogram again showed complete heart block.

Comment.—It seems probable to us that this case is also one of congenital heart block though the suspicion of lues and the frequent sore throat suggest the possibility of an infectious origin. Complete heart block found at the age of from 5½ to 6 years would almost surely point to congenital origin in the absence of a severe diphtheritic infection. The negative heart finding at the time of the throat operation in July, 1919, is not of great significance, if the size of the heart were not carefully determined and if the regular idioventricular rhythm happened to be 60, as it was found on occasion later.

SUMMARY

An unique case of congenital heart block is recorded in which the irregular pulse was observed before birth. This case also showed mongolian idiocy. A second case of probable congenital heart block is also reported. These two patients, with two other cases found in the literature, are tabulated with eight cases already recorded, making a total of eleven individuals with congenital heart block proved by graphic records, and one probable case also proved by electrocardiogram.

CLINICAL DEPARTMENT

PERITONITIS AS A COMPLICATION OF SCARLET FEVER *

ETHEL C. DUNHAM, M.D.
NEW HAVEN, CONN.

Peritonitis as a complication of scarlet fever is rare, in fact it is not mentioned in most standard textbooks. We saw one case last year in the New Haven Hospital.

REPORT OF CASE

A white girl, 5 years of age, was admitted Sept. 24, 1919, complaining of abdominal pain and vomiting.

Family History.—Unimportant.

Past History.—Negative, except that the child had developed scarlet fever two weeks previously and at the time of the onset of the present illness was convalescent, having been afebrile ten days.

Present Illness.—Developed twenty-four hours before admission. The onset was very acute with pain in the abdomen and vomiting, and these symptoms persisted.

Physical Examination.—The temperature was 102 F.; pulse, 160; respirations, 28. The child was prostrated, very pale and irritable. She was lying on her back with her knees drawn up. The tongue was heavily coated, the tonsils were enlarged but not inflamed. The cervical glands were slightly enlarged. The neck was slightly stiff. A few coarse râles were heard at the bases of both lungs. The heart was not enlarged. There were no murmurs. The pulse was regular, 160 per minute. The abdomen was level and tense. The child resented palpation in all parts of the abdomen, but tenderness and muscle spasm seemed more marked in the lower quadrants, especially on the right side and below McBurney's point. There was no dulness in the flanks. The extremities and reflexes were normal. The genitalia showed no vaginal discharge. The skin was dry and a fine branny desquamation was present over the body and was most marked on the extremities.

Laboratory Findings.—There was a leukocytosis of 22,300; polymorphonuclears, 85 per cent. The urine (catheterized specimen) was acid, clear, with a trace of albumin; no sugar; microscopically, many granular casts, a few leukocytes, no clumps of leukocytes.

Rectal Examination.—A rather indefinite sort of mass was felt on the right—not sharply defined; anteriorly, a resistance probably due to the bladder.

Diagnosis.—Acute appendicitis with general peritonitis. The patient was transferred immediately to the surgical service.

Operation.—On opening the peritoneal cavity, free pus—fairly thin—without odor was encountered, and a small pocket containing between 1 and 2 ounces was evacuated from the right pelvic fossa. The appendix was removed in the

* From the Department of Medicine (Pediatrics) Yale University School of Medicine, Affiliated with the New Haven Hospital and Dispensary.

* Received for publication May 5, 1921.

usual manner and the stump invaginated. It was normal, except for a fibrinous peritonitis of slight degree. The intestine was inspected quickly, no Meckel's diverticulum or other abnormality was found. The pelvis was examined and the right tube found very markedly injected, of a deep red color, and adherent to the surrounding structures by delicate fibrinous adhesions which were, perhaps, a trifle denser here than throughout the general peritoneal cavity. Smears and swabs were made from pus in the latter.

Report of Pathologic Laboratory.—The bacteriologic laboratory reported gram-positive cocci in the smears made from the pus obtained from the abdominal cavity at operation. Cultures from the peritoneal fluid showed the *Streptococcus hemolyticus.*

The surgical pathologist examined the appendix, which grossly was normal, except for a fibrinopurulent exudate on the peritoneal surface. On microscopic examination the mucous membranes showed no distinct pathologic process; the muscular layers were intact; the peritoneal surface showed an acute fibrinopurulent exudate.

Clinical Course.—The convalescence was delayed by measles followed by a purulent otitis media. November 8, the abdominal wound was entirely healed and the patient was afebrile, and she was discharged from the hospital Nov. 11, 1919, in good condition.

REVIEW OF LITERATURE

In the literature from 1903 to 1919 inclusive, the following cases are reported: McCollom and Blake,[1] in 1903, reported two cases of peritonitis which occurred in a series of 8,000 cases of scarlet fever. A boy, 5 years old, developed peritonitis twenty-three days after the appearance of the eruption. The abdomen was tapped and drained for a few days. A culture from the pus obtained from the abdomen showed the *Streptococcus pyogenes.* The patient recovered. A man, 31 years old, developed peritonitis twenty-three days after the onset of scarlet fever. At operation pus was found in the abdomen and a culture showed a streptococcus. The patient died twenty-five hours later and at the necropsy no local focus of infection was found.

M. M. Touraine and Fenestre,[2] in 1910, reported the following case: A boy, 14 years old, two weeks after an appendectomy, developed scarlet fever. Twenty-four hours later he developed symptoms of peritonitis which disappeared in a few days, and no operation was performed. They explain this as being due to the eruption present on the peritoneal surfaces or in the lymphatics, and state that it must be differentiated from the secondary peritonitis coming on in the desquamation period.

Hecker,[3] in 1912, reported a fatal case of scarlet fever, in which at necropsy an acute purulent peritonitis was found. He also cites a case of Jhons in Escherich's Clinic, severe and fulminating, in which peritonitis was found at the necropsy.

Teissier,[4] in 1914, states that he had seen in a hospital for contagious diseases five cases of fatal purulent peritonitis complicating scarlet fever,

---

1. McCollom & Blake: General Peritonitis Complicating Scarlet Fever, Boston M. & S. J. **149**:639, 1903; Boston City Hospital, M. & S. Rep., 39, 1903.

2. Touraine: La Peritonité de la Periode Eruptive, Tribune Med. Par. **43**:421, 1910; Bull. Soc. de Pediat. de Par., **12**:357, 1910. Touraine & Fenestre: Apropos de Complications Peritoneal de la Scarlatina, Ann. de méd. & chir. enf. Par. **15**:18, 1911.

3. Hecker: St. Petersburg med. Ztschr. **37**:263, 1912.

4. Teissier: Les Complications Peritoneal de la Scarlatine, Am. J. M. Sc., **157**:797, 1919.

without including cases of streptococcus peritonitis, developing in those ill at the same time with scarlet fever and puerperal infection. Of these cases, one was an infant, aged 7 months; one a child aged 6 years which died in the eruptive period; one, a child aged 15 years, death taking place in the period of desquamation; two other cases were fatal on the twelfth and fifteenth days after the onset of scarlet fever, one a female, aged 28 years; the other a girl, aged 12 years.

Summary.—Ten cases of peritonitis complicating scarlet fever are reported in the literature. In two cases the peritonitis developed in the eruptive period, one being fatal; in two cases in the desquamation period, one being fatal; in three cases the time of onset is not stated. The diagnosis in four of these cases was confirmed by operation or at necropsy. In the report of one case it is stated that the necropsy revealed no local focus of infection. A streptococcus was grown from the pus in two cases. Blood cultures are not reported in any of the cases.

Bibliography. Reviews literature from 1903-1919.

CONCLUSIONS

Peritonitis occurs as an infrequent and serious complication of scarlet fever. It is probably a blood stream infection of the peritoneum, and the streptococcus is the etiologic factor.

I am indebted to Drs. Harvey and Duffy for the surgical and pathological notes, respectively.

PROGRESS IN PEDIATRICS

REVIEW OF LITERATURE FOR 1920 ON NEUROLOGY OF CHILDREN *

LEWIS J. POLLOCK, M.D.
CHICAGO

BLOOD VESSELS

The tendency toward hemorrhage in the new-born, according to J. A. Foote [1] is frequently first manifested as intracranial hemorrhage and it is important to recognize that this may be and often is a local manifestation of a general condition. The early resort to lumbar puncture and the hypodermic administration of substances that tend to increase blood coagulability are rationally indicated in every case of suspected intracranial hemorrhage of the new-born, even prior to operation.

It was found by F. C. Rodda [2] that 50 per cent. of infants dying during delivery or during the first few days following, died of hemorrhage; apart from gross trauma other factors existed in the production of this hemorrhage and not always was the intracranial hemorrhage caused by obstetric procedures, many occurring after normal labor and in children with hemorrhagic tendencies. For this reason, blood coagulation tests are stressed.

The cause of intracranial hemorrhages are divided by J. B. Sidbury [3] into two general heads. First, spontaneous, or hemorrhage due to a general condition, as hemorrhage of the new-born; and, second, traumatism. Under the latter head the most common causes are (1) prolonged, tedious or hard labor, with or without instruments; (2) precipitate labor with injury to the child's head; (3) injudicious use of pituitary extract; (4) breech extraction of the after-coming head; (5) premature babies, who usually have very fragile blood vessels, which are not strong enough to undergo the amount of pressure necessary even in a normal delivery.

Among the symptoms described by the author, the following are mentioned as signs to bear in mind: Convulsions or twitching of one or more extremities, bulging fontanel (not a constant sign), nystagmus,

* Received for publication June 14, 1921.

1. Am. J. Dis. Child. **20**:18 (July) 1920.
2. J. A. M. A. **75**:452 (Aug. 14) 1920.
3. Arch. Pediat. **37**:545, (Sept.) 1920.

strabismus, which is more or less constant, increased reflexes, which may be more marked on one side. Stiff neck and Kernig may be present if the irritation is confined more to the base of the brain. The pulse is strong, full and at times slow. The respirations are irregular and at times simulate the Cheyne-Stokes phenomenon.

The author advises repeated daily lumbar punctures until the spinal fluid is clear of blood when the intracranial pressure is found to be increased on measurement. If this procedure fails to remove such signs as papillitis or twitching in any group of muscles, a decompression operation should be considered.

Cranial sinus thrombosis in children is described by S. Oppenheimer [4] who thinks that the symptomatology is similar to that of adults. Two forms of thrombosis are described: (1) Primary or marasmic; and (2) secondary or infective, sometimes termed inflammatory. Marasmic thrombosis occurs less frequently than the infective and is most frequently located in the longitudinal, rarely in the lateral and still more rarely in the cavernous sinuses. It is met with in the young most frequently during the first two years of life and more especially during the first six months of infancy. Exhausting diarrhea is one of its most potent causes, although acute and chronic pulmonary affections play an important etiologic part. The diagnosis of primary sinus thrombosis in children is difficult and is seldom made during life. In view of the impossibility of a definite diagnosis in most cases, the treatment is wholly symptomatic.

Secondary or infective sinus thrombosis is much more frequent and follows extension of inflammation from parts contiguous to the sinus wall. It is the term usually applied to thrombosis which arises from invasion of the sinuses by pathogenic microorganisms. In children, infective sinus thrombosis may follow skull fractures, scalp wounds, anthrax of the lip, mouth, nasal and orbital cavities, erysipelas of the face and forehead, furunculosis of the lips, face or neck. By far the most frequent cause is suppurative middle ear disease. It may also occur as a complication of a diphtheritic infection of the middle ear or of scarlet fever, but more often from measles and influenza.

The most important general symptom of lateral sinus thrombosis is fever which rises excessively high in young children. In older children there may be headache, pains in the occipital region and tenderness on palpation along the jugular vein, due to lymph node enlargement. Dilatation of the cervical veins and the possible hardening of the internal jugular vein, with or without edema behind the mastoid process, are signs of diagnostic significance.

4. Arch. Pediat. **37**:65 (Feb) 1920.

In establishing the diagnosis of sinus thrombosis pneumonia, typhoid fever, acute endocarditis, malaria and certain cases of scarlatinal infection must be excluded. The author emphasizes the importance of early diagnosis because operative procedures are attended by the cure of a great many cases which otherwise would terminate fatally.

MENINGES

An early diagnostic sign in basilar meningitis is described by G. Gingold [5] as follows: By flexing the head on the chest either a bilateral or a unilateral strabismus develops which will last as long as the head is kept in a flexed position, and disappears as soon as the head is relaxed. In many cases the strabismus is accompanied by retraction of the upper eyelids. In some cases he noticed a contraction of the pupils. This "reflex" strabismus was present in almost every case that came under the author's observation.

The diagnosis and treatment of hydrocephalus resulting from strictures of the aqueduct of Sylvius is described by W. E. Dandy.[6] He concludes that cicatricial stenosis of the aqueduct is the most frequent lesion in congenital hydrocephalus (about 50 per cent.) and is found in a large percentage of cases of hydrocephalus occurring in infancy and early childhood. The stenosis may occupy the entire length of the aqueduct or varying parts; it may be only a thin, even transparent membrane. Again, the stricture may be only partial. Strictures of the aqueduct of Sylvus can be diagnosed and localized accurately. The indigo-carmine test will indicate that an obstruction is present; ventriculography will be the means of precisely locating the obstruction. Spontaneous relief is not possible. Surgical attempts to drain the fluid from the third ventricle to the exterior of the brain have all proved futile. The openings invariably close and the fluid cannot absorb in the subdural space.

He suggests a new surgical procedure by which a new aqueduct of Sylvius is constructed. A tube is left in place for from two to three weeks, whereby it is hoped the epithelium will regenerate and establish a new canal. This operation has been performed on two patients, both of whom recovered from the operation. One patient died of pneumonia several weeks later; the second seems to be well one year after the operation.

Although tuberculous meningitis is considered as being almost universally fatal, A. W. Hollis and I. H. Pardee [7] report four cases

5. Arch. Pediat. **37**:19 (Jan.) 1920.
6. Surg. Gyn. Obst. **30**:324 (April) 1920.
7. Arch. Int. Med. **26**:49 (July) 1920.

of recovery following the intraspinal administration of antimeningococcic serum. Two of these patients showed tubercle bacilli in the spinal fluid. They believe that the intraspinal injection of the serum has two distinct actions: first, by adding to the spinal fluid certain antibodies which it is able to develop itself; and, second, by the introduction within the dura of a foreign protein in the form of horse serum.

The cerebrospinal fluids of forty-eight cases were studied by N. Novick.[8] In order to ascertain whether the percentage of bovine infection in tuberculous meningitis is appreciably greater, perhaps, than is commonly accepted; whether the bovine type of virus has a special predilection for the meninges. Of the forty-eight strains of tubercle bacilli isolated from the cerebrospinal fluid of forty-eight clinical cases of tuberculous meningitis, three of the strains proved to be of the bovine type. In the analysis of 10,040 cases by Rosenau, whom the author quotes, an alarming percentage of bovine infection in children under 5 years (49 per cent.) is found. Milk entering as the chief element in the diet of children probably serves as a means of transmission of tuberculous disease.

Puncture of the cisterna magna is described by James B. Ayer[9] for the diagnosis or treatment of postmeningitic subarachnoid block: this results from adhesions which cut off the communication between the different parts of the cerebral and spinal subarachnoid space. A case of staphylococcus meningitis is related in which lumbar puncture yielded only 7 c.c. of clear fluid rich in albumin, but almost without cells and with no micro-organisms, while the cistern fluid was purulent, under high pressure, with numerous cocci. The cistern was washed out with salt solution and at a subsequent puncture autoserum was injected. The patient recovered.

ENCEPHALITIS

Epidemic or lethargic encephalitis in children is discussed by J. B. Neal.[10]

There is a gradual onset, followed by marked lethargy and asthenia; headache; low, irregular temperature; frequently cranial nerve palsies. Other paralyses may occur. A masklike expression is often present. The onset may be sudden and is so more frequently in children than in adults. Other striking features that may be present are, catatonia, marked tremors, choreiform movements, profuse sweating, insomnia, delirium, and a marked twitching of certain groups of muscles. A

8. J. M. Research **41**:239 (Jan.) 1920.
9. Arch. Neurol. & Psych. **4**:529 (Nov.) 1920.
10. Arch. Pediat. **37**:321 (June) 1920.

slurring, hesitating speech, with a very slow response is quite characteristic. Disturbances of vision, either diplopia or blurring are fairly common, and are very diagnostic.

The course of the disease is often remarkable for the transient changes in the condition of the patient either for the better or the worse. One of the most striking features of the disease in adults is the prolonged course, which in children is unusual. A differential diagnosis in children must be made from tubercular meningitis, brain tumor, meningism with some unknown underlying cause, syphilitic involvement of the central nervous system, and poliomyelitis or poliencephalitis and meningitis. The diagnosis from tuberculous meningitis is difficult. In a case of two or three weeks' standing, the patient does not seem to be as ill when suffering with encephalitis. Vomiting is a less constant feature and the pulse is more likely to be regular in encephalitis than in tuberculous meningitis. The spinal fluid examination may serve to differentiate too.

Brain tumor is comparatively rare in children, and usually shows a more protracted course than does encephalitis. Choked disc does not occur in encephalitis although some edema may be present. Meningism may be ruled out by a normal spinal fluid. When changes are found in the spinal fluid, some underlying cause, such as whooping cough, inflammation near the meninges, mastoid or sinus involvement or otitis media must be ruled out before assuming that it is a simple case of meningism. Syphilis of the central nervous system is less common in children and, therefore, is seldom a problem in differential diagnosis. The diagnosis from the encephalitic form of poliomyelitis is very difficult. From various forms of acute purulent meningitis, encephalitis may be differentiated by the examination of the spinal fluid which in the former will show varying degrees of cloudiness, excess of polymorphonuclears, and a diminished or absence Fehlings' reaction.

The blood picture in encephalitis is not characteristic. A slightly leukocytosis may be present. Blood cultures are negative and the urine usually is negative.

The spinal fluid is clear and usually increased in amount. The cells are slightly or moderately increased, the great majority not running higher than in poliomyelitis. The albumin and globulin are increased. Although Neal states that the reduction of Fehlings' solution is normal, it has been found by other workers that a characteristic feature of the spinal fluid is the excess of reduction. The gold chlorid curve duplicates those obtained in poliomyelitis fluid.

E. Wieland [11] reports four cases of epidemic encephalitis in children. In three of these cases the pandemic of grippe played no rôle, and in

11. Schweiz. med. Wchnschr. **50**:581, 1920.

the fourth case, it probably did not act as an etiologic factor. All of his cases showed the pathognomonic lethargy. The first case showed after a four day prodromal afebrile period, the onset of a choreic delirious stupor with high fever, tachypnae and meningism, following which there developed a brachiofacial paralysis of crossed type. At the beginning, the diagnosis lay between meningism and purulent meningitis, the results of the lumbar puncture ruling these out. Brain abscess was thought of and an exploratory brain puncture was performed with negative results. The second case showed an afebrile lethargy with rigidity of the neck and Kernig sign. It was an abortive case. The third patient, after a period of somnolence and stupor developed marked motor restlessness with hallucinations with choreiform movements in the arms and legs. The fourth patient showed during the prodromal stage, headache, diplopia, ptosis, rigidity of the pupil and lethargy. In the treatment he advises large doses of potassium iodid.

Some advance has been made in the study of the cause and pathology of lethargic encephalitis in the adult form and this knowledge is applicable to the condition occurring in children. C. V. Economo [12] believes that the disease is always produced by a diplostreptococcus.

Lethargic encephalitis and influenzal encephalitis are regarded as identical by H. Weiss [13] and a similar view is held by W. Lowenthal [14] and O. Speidel.[15]

Boccolari [16] found a hemispherical diplococcus slightly larger than the meningococcus and G. Gabri [17] obtained a coccus resembling the micrococcus tetragenus. A gram-positive diplococcus was obtained by blood culture in three cases by A. Maggiora, M. Mantovani and T. Tombolato.[18]

The globoid organism of Strauss and Loewe [19] is discussed further by these investigators. They have been able to produce in rabbits and monkeys lesions typical of this disease by Berkfeld filtrates of brain material, nasopharyngeal mucous membrane and nasal washings. The virus has been passed through many series of animals. By means of the ascitic tissue culture method of Noguchi they have been able to cultivate a minute, filterable organism which has been recovered from animals that have been inoculated with virus and which have succumbed

12. Neurol. Centralbl. June 1, 1920; Policlinico (sez. med.) **27**:93, 1920.
13. Orvosi Hetilap, 1920, No. 7.
14. Deutsch. med .Wchnschr., 1920, No. 11, **46**:289.
15. Münch. med. Wchnschr. **67**:630 (May 28) 1920.
16. Policlinico **27**:100 (Jan. 26) 1920.
17. Policlinico **27**:106 (Jan. 26) 1920.
18. Riforma med. **36**:114 (Jan.) 1920.
19. J. Infect. Dis. **27**:250 (Sept.) 1920.

to the experimental disease. The cultures thus obtained from animals have produced the disease when injected into other animals and the organism again recovered. As a method for differentiation of epidemic encephalitis from epidemic poliomyelitis, they suggest that rabbits are susceptible to infected material from epidemic encephalitis and not from poliomyelitis.

The topic of contagion is discussed by A. Netter [20] who cites the case of a child taken to Paris four weeks after the onset of the disease and transmitting it to his sister. He quotes the observations of MacIntosh and Turnball of twelve cases of undoubted encephalitis among the eighteen pupils and three employes of an English boarding school for young girls: twelve of the twenty-one residents of the house were taken ill and four died.

P. Marie and C. Tretikoff [21] in a new article confirm the correctness of their previous communication relative to the pathology of the disease. They emphasize as the principal features of the disease, the early occurrence of perivascular infiltrations, principally located about the gray matter. The infiltrations consist chiefly of lymphocytes but plasma cells are fairly common while polymorphonuclear cells are rare.

In two cases of a delirious type of encephalitis with marked choreic movements, Peter Bassoe [22] reports that the pial infiltrations as well as satellitosis and neuronophagia in the cerebral cortex were relatively more marked than in the usual types of the disease. However, even in these cases the maximum changes were found in the usual locations.

SYMPTOMATOLOGY

The encephalitis epidemic of 1920 in Austria is discussed by C. V. Economo,[23] who points to the three stages of the hyperkinetic cases: an initial stage with fever, severe pains, delirium tremens and herpes which is followed by myoclonic twitching and severe movements, and then the lethargic stage.

The excitomotor phenomena which persists after the acute stage of the disease has subsided are divided by P. Marie and G. Levy [24] into choreic movements, bradykinetic oscillations, which are slow, regular movements of large amplitude involving the proximal part of one or both limbs of the same side, myoclonic movements, simple tremors, movements limited to the face, and a Parkinsonian symptom-complex.

---

20. Presse méd. **28**:293 (April 7) 1920.
21. Ann. d. méd. **7**:1 (Jan.) 1920.
22. J. A. M. A. **74**:1009 (April 10) 1920.
23. Wien. klin. Wchnschr. **33**:324 (April 15) 1921.
24. Rev. Neurol. **36**:513 (June) 1920.

In the myoclonic form of encephalitis, R. C. Hamill [25] showed that the movements had a definite time relation to the respiratory movements, being either equal to or double their rate.

Under the name of acute infections myoclonus multiplex, J. Ramsey Hunt [26] gives a full description of the symptoms of this type of disease. LaSalle Archambault [27] described the choreic athetoid and choreic psychotic syndromes in encephalitis.

OTHER TYPES OF ENCEPHALITIS

A. S. Root [28] reports a case of what he supposes to be focal hemorrhagic encephalitis in an infant 15 months old who for three weeks had been in a state of profound somnolence and who improved strikingly after a transfusion of blood from her mother.

CONVULSIONS IN WHOOPING COUGH

Convulsions in whooping cough were observed in twenty-nine cases out of a series of 342 cases by F. Reiche.[29] The greatest number of convulsions were observed in children under 3 years of age. The direct cause of the convulsions varied. In one case there was a tonsillitis; in three cases there was an infection of the meninges; in one case there was an otitis media, in five cases the whooping cough was complicated by tuberculosis, one of these being tuberculous meningitis and one miliary tuberculosis; in three cases there was a sinus thrombosis and in seventeen cases no cause other than the whooping cough could be found. All of the twenty-nine cases terminated fatally.

MISCELLANEOUS

A case of congenital athetosis is reported by Maas.[30] This patient was operated on by Borchart. The right cortex was exposed and a strip about 3x1x2 cm. excised. The athetoid movements disappeared and a weakness developed in the thumb. Shortly after power returned but unfortunately when it did the involuntary movements returned as well.

TUMOR

Neuroblastoma Sympathicum.—A case occurring in a boy, 13 years old, is reported by P. C. Gunby.[31] Failure of vision, weakness, slight headache and bilateral papilledema were the chief general symptoms.

---

25. Arch. Neurol. & Psych. **4**:44 (July) 1920.
26. Neurol. Bull. **2**:391 (Nov.-Dec.) 1919.
27. Arch. Neurol. & Psych. **4**:484 (Nov.) 1920.
28. Arch. Pediat. **37**:538 (Sept.) 1920.
29. Ztschr. f. Kinderh. **25**:28 (May) 1920.
30. Neurol. Centralbl. **39**:584, (Nov.) 1920.
31. Am. J. M. Sc. **160**:207, 1920.

No local signs were found. The entire vertex was nodular with small tumors. At necropsy a large tumor supposed to be a malignant hypernephroma was found in the left suprarenal and multiple metastatic growths in the skull and sternum were found which on microscopic examination did not show the characteristics of a hypernephroma and the diagnosis of a neuroblastoma was confirmed.

A solitary tubercle of the midbrain is reported by J. H. M. Knox.[32] His case was that of a colored boy, 3 years old, who had been perfectly well until six months previously when he stopped crying. Four months later, it was noticed that he trembled when he fed himself. At this time, drooping of both eyelids was noticed, and on examination, a lateral deviation of the eyeball to the right was noted; the right eye frequently showed nystagmus. The gait was normal, and the deep reflexes with the exception of the knee jerks, which were slightly increased, were normal. Within two weeks he had two attacks of weakness, became drowsy and had difficulty in standing and walking. A slight secondary optic atrophy was present and roentgenologic examination showed moderate internal hydocephalus. The necropsy revealed a tubercle the size of a hickory nut in the midbrain.

A case of blastomycosis of the brain with abscess formation occurring in a boy, 17 years old, is reported by J. T. Moore.[33] The infection resulted from the habit of holding a stick or splinter in the mouth. He developed an abscess behind and above the left ear. Blastomycetes were found in the pus. At necropsy four abscesses were found in the frontal and parietal regions of the left hemisphere.

THE BASAL GANGLIA

Dystonia musculorum deformans has been studied by H. W. Frauenthal and C. Rosenbeck[34] who describe and illustrate a case in a Russian Jewess, 17 years old. The following conclusions were drawn:

> A summary of the clinical features of this case shows that the patient at a very early age manifested peculiar, involuntary movements—at first limited to an extremity and then, gradually and definitely over a period of several years, various muscle units affected a disposition to behave in this abnormal manner. At present—ten years after the onset—the entire body seems to be convulsed in a relentless dystonia. Evidently no further progress is possible unless it be the muscles innervated by the cranial nerves which thus far have escaped. This is in accord with most writers on the subject who have emphasized the absence of cranial nerve involvement. That these, however, may also be implicated in their supranuclear pathways has definitely been established by

32. Am. J. Dis. Child. **20**:436 (Nov.) 1920.
33. Surg. Gyn. & Obst. **31**:590 (Dec.) 1920.
34. J. Nerv. & Ment. Dis. **52**:134 (Aug.) 1920.

several authenticated observations. The racial predilection, i. e., its limitation to offspring of Polish or Russian Jews is not without interest. The vulnerability of the nervous system in this race to certain types of degenerative disease is thus accentuated.

E. W. Taylor [35] also contributes an article on this disease, reporting two cases in a brother and sister, Russian Jews. He prefers the term dystonia lenticularis. He believes that there exists a type of motor disorder characterized by hypertonia and hypotonia giving rise to a destructive form of gait and motor disturbances in general, sufficiently definite to demand a provisional classification. Although occurring with frequency in children of the Jewish race, it is not confined to that race nor does it always occur in childhood. It is sporadic rather than truly familial. It is not to be sharply differentiated from various other forms of motor disorder of presumable extrapyramidal origin. It is due to structural alterations of the lenticular nucleus, has no defined pathologic anatomy but its association with alterations of the liver is probable.

Acute cerebrocerebellar ataxia is described by J. P. C. Griffith,[36] who reports three new cases consequent to acute cerebellar encephalitis. With this are always combined symptoms indicating an involvement of the large brain as well and the title of "cerebro cerebellar encephalitis" or "cerebro-cerebellobulbar encephalitis" is consequently to be preferred. The cause varies decidedly. In the majority of cases previously reported in medical literature, some infectious disease had preceded the attack. Among the symptoms most frequently seen are unconsciousness usually of but short duration, ataxia, affection of speech, disturbance of mentality which is usually temporary, nystagmus, and loss of power. The prognosis would appear good as to life and of the seventeen cases collected from literature, complete recovery occurred in a considerable number of cases and it would appear that the disease will leave no traces in the majority of instances.

SPINAL CORD

Hemorrhage of the spinal cord at birth is discussed by Charles W. Burr [37] who reports two cases with cervical segment lesions, both being breech presentations. He refers to the report of Spencer who in forty-four cases in which the spinal cord was examined found in eighteen edema and congestion and in thirty-six hemorrhage of the cord. In one of Burr's cases there was hemorrhage, swelling and

35. Arch. Neurol. & Psych. **4**:417 (Oct.) 1920.
36. Am. J. Dis. Child. **20**:82 (Aug.) 1920.
37. Am. J. Dis. Child. **19**:472 (June) 1920.

myelitis. He is inclined to believe such hemorrhage spontaneous and not caused by direct violence but by rupture of overfull vessels from pressure of soft parts during birth.

Rupture of the spinal cord in dystocia is discussed by F. H. Kooy.[38] His case is unique as the child lived for nearly nine years. The child was born by version and extraction, the shoulders being delivered by the method of Mueller. From her birth until her death, about nine years afterward, she suffered from paraplegia (except for flexion of the legs at the hip joint), from total or almost total loss of sensibility of the legs and from incontinence of urine and feces and a decubitus.

The significance of xanthochromia of the cerebrospinal fluid is discussed by Isaac A Abt and I. Harrison Tumpeer.[39] They report an infant born in the eighth month of gestation who lived thirty-seven days and manifested the signs of an internal hydrocephalus, pyelitis and a bronchial pneumonia. They feel that the xanthrochromia was due to subpial hemorrhage as a result of meningo encephalitis.

SYPHILIS OF THE NERVOUS SYSTEM

Nerve deafness due to congenital syphilis is reported by W. B. Kay[40] occurring in three children, 7, 5 and 4 years old, respectively. In each of them the disease began between the first and second year. The Wassermann reaction was positive in the oldest child and in the parents. Kay believes these children to show the manifestation of late hereditary syphilis.

P. Hutinel[41] discusses the relation of hereditary syphilis and dystrophy. He states that hereditary syphilis produces two types of groups, the first in which specific alternations are produced by the trepenoma or reactions of this organism, and the second class in which nutritional difficulties occur. Such dystrophic changes may be local, partial, frequently multiple and in some general. They attack chiefly the endocrine glands and the offspring of such patients may show hereditary dystrophies.

A case of juvenile tabes is reported by Kerr[42] occurring in a child 14 years old and characterized by lightning pains, primary optic atrophy and absent knee jerks. The examination of the blood was negative.

Toni Schmidt Krapelin[43] details thirty-nine certain cases of juvenile paretics among the 2,184 admissions to the psychiatric clinic

38. J. Nerv. & Ment. Dis. **52**:1 (July) 1920.
39. Am. J. Dis. Child. **20**:153 (Sept.) 1920.
40. J. A. M. A. **74**:1162 (April 24) 1920.
41. Arch. de méd. d. enf. **23**:5, 145, 205 (Jan.-April) 1920.
42. Lancet **1**:598 (March 13) 1920.
43. Ueber die Juvenile Paralyse, Berlin, 1920, Julius Springer.

at Munich in the last fifteen years. Twenty-six were males, thirteen were females. There were eight doubtful cases, or cases in which an erroneous diagnosis was made, and seven cases of "preparalysis" in children who showed no clinical signs of metasyphilitic affection of the central nervous system, but in whom serologic findings characteristic of general paresis were more or less accidentally discovered.

As regards the serology in ancestry, results are given of forty-eight persons of twenty-one families. A positive blood Wassermann occurred in five out of eleven fathers, fourteen out of eighteen mothers and in nine out of nineteen brothers and sisters. Alcoholism was found in 20 per cent. of the cases. Over one-fourth of the cases showed general arrest of development, one-third were mentally deficient and among the early signs was the change in character. An acute onset with hemiplegia and other focal symptoms and major epileptiform attacks were relatively frequent, suggesting a combination of this disease with brain syphilis. Optic atrophy without other tabetic symptoms is comparatively frequent. Total immobility of the pupil is more common than simple loss of the light reflex. As a forerunner of the characteristic speech disorder there is sometimes observed in paralytic and preparalytic children a peculiar hurried, toneless and puffing way of speaking. Periods of excitement are common but an agitated condition persisting throughout was seen only in about 10 per cent. of the cases. A majority of the cases showed a typical Wassermann reaction in the blood serum and spinal fluid. No therapeutic results worth mentioning were obtainable by any known treatment.

MUSCULAR ATROPHIES

Amyotonia congenita is described by N. O. Pearce.[44] He reports five cases, two appearing in twins. In reviewing the literature he states that 132 cases have now been reported. In his cases the symptoms were present at birth, in four affecting the upper extremities and in all the lower extremities. The knee jerks were absent in three, very weak in one and sluggish in one case. Pad feet were present in three cases. In the first of his cases an exhaustive metabolic study was carried out and a lowered creatinin excretion was found in addition to the excretion of creatinin, on a low protein diet. A normal uric acid excretion, and increased rest nitrogen accompanied by an increased neutral sulphur and a normal phosphorus excretion was present.

A case with complete histologic examination of the nervous and muscular systems is reported by J. B. Holmes.[45] The spinal cord was relatively large and the anterior roots were diminished in size. The

44. Am. J. Dis. Child. **20**:393 (Nov.) 1920.
45. Am. J. Dis. Child. **20**:405 (Nov.) 1920.

large cells of the anterior horn were strikingly few in number and in part were represented by cells that are much smaller in size but otherwise of the same appearance. Only infrequently was a cell of normal size found, but save in size, such cells are of perfectly normal appearance. There was a complete absence of acute or inflammatory condition, myelinization was normal, and there was no evidence of recent degeneration. In the muscles are found fibers of small, apparently healthy muscle fibers, intermingled with bundles of hypertrophied fibers. The small fibers appeared to represent less fully developed bundles of muscle tissue. The component muscle cells are embryonic in appearance, resembling most closely muscle cells of a human fetus in the third month. "The histopathologic findings are best explained on an assupmtion of a delayed or retarded embryonic development affecting certain motor cells of the anterior horns and certain groups of developing muscle cells (fibers)."

The relationship of amyotonia congenita and the congenital familial spinal muscular atrophies is discussed by K. H. Krabbe [46] who reports seven cases. He believes that cases which have been described as amyotonia congenita really represent two different diseases. One of these, true amyotonia congenita, is a benign disease consisting of hypotonia, hyperflexibility and weakness, but no muscular atrophy. From this condition the patient recovers if an intercurrent disease does not produce death. Other cases, including six of his own, are to be considered cases of congenital familial progressive muscular atrophy, resembling the Wernicke-Hoffmann type of muscular atrophy.

On the other hand, E. J. Huenekens and E. T. Bell [47] believe the two conditions to be extreme types of the same disease, represented by Erbs' juvenile form of muscular dystrophy and the hereditary form of Leyden and Moebius.

PERIPHERAL NEBVES

Obstetrical palsies are considered to be due to stretching and tearing of the roots of the brachial plexus by J. W. Sever.[48] Girls and boys are equally affected. The upper arm type is the most frequent; both arms are very infrequently affected. They are practically always associated with difficult labor involving either forceps or force. They are more frequent in head deliveries, and they may be associated with fracture of the clavicles. He states that it is not the result of posterior dislocation or fracture of the humerous. On the other hand, J. Turner Thomas [49] states that in most cases such paralysis disappears, and in

46. Brain **43**:166 (July) 1920.
47. Am. J. Dis. Child. **20**:496 (Dec.) 1920.
48. Canadian M. A. J. **10**:141 (Feb.) 1920.
49. Am. J. M. Sc. **154**:207 (Feb.) 1920.

all cases in which serious crippling of the limb was found, a posterior subluxation of the shoulder joint was present. He argues that the basic causal lesion was in the shoulder joint and not in the brachial plexus.

M. Clauss [50] in discussing multiple neuritis in childhood states that aside from the neuritis following diphtheria there are only forty cases recorded. Most of these have followed acute infectious diseases particularly mumps, typhoid fever, scarlet fever, influenza, whooping cough, sore throat, acute articular rheumatism and appendicitis. The prognosis in multiple neuritis in childhood is good. He gives a history of six cases, one of particular interest associated with or followed by a tuberculous iridocyclitis which had been treated for six weeks with tuberculin.

DeLavergne [51] reports in diphtheritic paralysis a meningeal reaction characterized by an excess of glucose, albumin and a normal cell count in the spinal fluid. An interesting case of post diphtheritic paralysis of the respiratory muscles occurring in a girl ten years old who recovered after prolonged artificial respiration is reported by W. M. Marriott.[52]

The treatment of postdiphtheritic neuritis is discussed by H. Gödde.[53] He reports two cases in which steady improvement occurred following the administration of serum in large doses and he is inclined to agree with Paessler and Heubner in their administration of antitoxin.

Acrodynia, a polyneuritic syndrome resembling pellagra, and occurring in children under four years is discussed by Albert H. Byfield,[54] who reports seventeen cases. The chief features are:

1. *Nervous Symptoms.*—Paresthesias of the hands and feet leading to incessant scratching or chewing of the extremities. The reflexes are diminished in most cases. Dulness and apathy alternate with extreme restlessness and sleeplessness.

2. *Skin and Hair.*—The hands and feet are cyanotic and cold and become the seat of an erythematous rash which is confluent and most marked on the fingers and toes. Desquamation is present and most marked distally. Falling and pulling out of hair is common.

3. Loosening and falling out of the teeth.

---

50. Deutsch. Ztschr. f. Nervenh. **65**:169 (March) 1920.
51. Bull. et mém. Soc. méd. d. hôp. de Par. **44**:1246, 1920.
52. J. A. M. A. **75**:668 (Sept. 4) 1920.
53. Neurol. Centralbl. **39**:532 (Aug. 16) 1920.
54. Am. J. Dis. Child. **20**:347 (Nov.) 1920.

4. *Anorexia and Resulting Emaciation.*—The rather common acetonuria is probably the result of starvation superinduced by the anorexia.

5. *Leukocytosis* (11,000-30,000).

The duration of the disease varied from two to eight months. The mortality appears to be low. Two of the first cases seen were fatal but forced feeding had not been employed.

As to etiology, it appears that dietary error is not responsible as most of the patients had received proper feeding. An infectious origin is more probable and it has been suggested that we are dealing with a sequel of influenza. In this connection it is interesting to note that the term acrodynia was first used in 1828 to designate a similar affection also known as epidemic erythema. An influenza epidemic existed at that time.

ANOMALIES OF GROWTH

An endocrine origin and inclusion in the heredo-degenerations for facial hemiatrophy is suggested by F. Boenheim,[55] who reports several cases and analyzes the subject very thoroughly. His first patient, a man, aged 32 years, was a veritable giant, measuring 198 cm. in height. He was left-handed. In early childhood atrophy of the right side of the face began and came to a standstill at 15 years of age. At 29 or 30, a similar process began on the left side of the face and was still progressing at the time of examination. The growth of hair on the trunk, as well as on the most atrophic parts of the face was deficient. The right upper teeth were smaller than the left, as was the right ear. There were no acromegalic features and the sella turcica was normal. There were no signs of a lesion of the sympathetic. A supernumerary nipple was present on the right side. The subsequent involvement of the other side of the face is not very unusual as Coenenberg found it in eighteen of 250 cases.

Congenital Hemihypertrophia Totalis.—H. R. Coston[56] reports a case of hemihypertrophy totalis in a male child, aged 22 months. He was the fourth child of healthy parents of rather low mentality. The other three children have been mentally superior to their parents. The patient had never been ill and seemed normal mentally. The birth followed a quick and easy labor. The mother was well during pregnancy. There was available a history through six generations with only one cousin in any way defective. This child, a second cousin on the mother's side, had six toes on the right foot. There was no idiocy, insanity, epilepsy or deformity other than the one mentioned in the

55. Deutsch. Ztschr. f. Nervenh. **65**:219 (May) 1920.
56. Med. Rec. **97**:222 (Feb. 7) 1920.

family. Immediately after birth, it was observed that the right side was "that of a 10 pound baby while the left side was that of a 7 pound baby."

Coston remarks that cases of hypertrophy are usually on the right side and there are many cases of partial hypertrophy confined to a single limb or one side of the face. Occasionally cross cases are seen.

Edward A. Park and Grover F. Powers [57] report two cases of scaphocephaly with malformation of the extremities. They point out that the deformities were not limited to the hands and feet in a number of the cases recorded.

A study of achondroplasia is reported by Thomas Foster Wheeldon [58] who states that achondroplasia is characterized by symptoms of dwarf growth (shortness of extremities, vertebral column and chest, and looseness of the skin) and symptoms of infolding (kyphosis basoes crania, sagital narrowing of the foramen magna, depression of the nasal bridge, narrowing of the choanae, reduction in size of the sella turcica with consequent reduction in size of the pituitary body, and changes in the spine). The changes of achondroplasia are probably due to the smallness of the amnion, except in rare cases and are produced between the third and eighth weeks of intrauterine life. They consist mainly in a retardation of ossification of the epiphysis and the diminished production of endocranial bone, while the periosteum produces a comparatively normal amount of bone. Roentgenographic examination shows that near the epiphysis, the diaphysis become cup shaped producing a T-shaped outline without any disturbance of the epiphyseal line or zone of proliferation, though these may be uneven and take on more or less phantastic shapes. Two of the cases presented showed a new symptom, a wedge-shaped vertebra, which falls in the group of symptoms of infolding and fortifies the belief that the state of achondroplasia is produced by smallness of the amnion.

The enlargement of the head in these dwarfs has recently been studied by W. E. Dandy [59] and attributed by him to slight hydrocephalus.

A case of dwarfism attributed chiefly to general infantilism is reported by C. Sternberg.[60] His patient was a boy, aged 17, and was 36¼ inches tall. He was said to have been of normal size at birth but at the age of 1½ years he developed curvature of the spine and retardation of growth. He died as the result of tuberculous spondylitis.

---

57. Am. J. Dis. Child. **20**:235 (Aug.) 1920.
58. Am. J. Dis. Child. **19**:1 (Jan.) 1920
59. Bull. Johns Hopkins Hosp. **32**:5 (Jan.) 1921.
60. Beitr. z. path. Anat u. z. allg. Path. (Oct. 15) 1920.

He was classified as a case of true dwarfism. The bones other than the spine were normal and all the epiphyseal lines wide open. The appearance of the body was decidedly infantile. The genitalia were small and there was no trace of beard, axillary or pubic hair. The testicles showed primary defective development and for this reason, it was felt that the dwarfism could not be contributed to hypophyseal deficiency which would have caused atrophy of the testicles.

Mongolianism is regarded by E. Apert [61] as one of the extremely varied group of abnormal infants which with congenital myxedema occupy two special gorups each one different from idiocy, imbecility, retardation of evolution or mental anomaly. He has found that in the great majority of cases the Mongolian is frequently the last of a numerous family, the mother relatively advanced in age and weakened by previous pregnancies. In general, the Mongolians will always need guidance, they will lack intuition and judgment. They will remain below standard but can be sufficiently restored to escape feeble-minded institutions.

MENTAL DEFICIENCY

The effect of influenza on feeblemindedness is studied by K. A. Menninger [62] who concluded that the usual effect of influenza on the brain is not the production or precipitation of feeblemindedness, and if it ever produces feeblemindedness it is probably by means of an encephalopathy. On the other side, of those already manifesting mental lack, certainly a few are influenced adversely by influenza, and the symptoms of feeblemindedness are aggravated, an aggravation which may be predominately in the intellectual sphere, in the emotional sphere or in the volitional sphere. Psychoses of an indeterminate type are occasionally precipitated by influenza in the feebleminded, even as in normal persons. At least occasionally, though rarely, the effect of influenza on feeblemindedness may be symptomatic amelioration.

Edward A. Strecker,[63] in a study of fourteen mentally defective and eighteen mentally retarded cases concluded that in 56 per cent. of all cases, congenital mental deficiency did not exist, and that in 84 per cent. of the retarded cases there were significant underlying physical factors on which the mental retardation depended. There were six cases of congenital syphilis, one of tonsillitis and organic heart disease, one of rachitis, one of organic brain disease, one of hypopituitarism and five who, although they had no definite organic disease, were undernourished and underdeveloped as the result of economic or environmental conditions.

61. Bull. méd. **34**:563 (June) 1920.
62. J. A. M. A. **75**:1044 (Oct. 16) 1920.
63. J. A. M. A. **75**:659 (Sept. 4) 1920.

William Healy [64] discusses the occurrence of certain signs and symptoms in delinquents which are significantly correlated with etiologic facts of great importance in the interpretation of the cases. These symptoms are indicative of some disturbance in the mental life of the patient and in the cases cited, consisted chiefly of disturbing sex experiences. From an intensive study of a large number of young delinquents, he has been led to the conclusion that about 10 per cent. are sufferers from the inner turmoil that we call mental conflict. He calls attention to the importance of this field and the remarkable accomplishments of therapeutic accomplishments.

The importance of an outpatient clinic in connection with an institution for the feebleminded is pointed out by Walter E. Fernald [65] who described the system that has been developed for the examination of patients applying to this department. Among the types of advice given may be included institutional care, home care, special class, private school, private teacher, change of teacher, let-up school pressure, take out of school and go to work, change of work, treat as delinquent, special medical or surgical treatment, country life, vocational training, add new interests and recreation, place in selected family, modify home environment, etc. It is a striking fact that of the thousands of cases diagnosed as feebleminded at this clinic since 1891, the majority have not subsequently applied for admission and are not known to have misbehaved seriously.

---

64. Arch. Neurol. & Psych. **4**:680 (Dec.) 1920.
65. Am. J. Insanity **77**:227 (Oct.) 1920.

Book Review

THE DISEASES OF INFANTS AND CHILDREN. By J. P. Crozer Griffith, M.D., Ph.D. With 436 illustrations, including 20 plates in colors. Two volumes. Philadelphia and London, W. B. Saunders Company, 1921.

The author has made many clinical contributions of high merit to pediatric literature. He combines a rich personal experience with a very unusual knowledge of literature. It is to be regretted that, in part, the illustrations are not very good. The colored plates, however, are excellent. A detailed review of this rather comprehensive work would take too much space and is not necessary, as it can be recommended very highly to the pediatrician. Some features might, perhaps, be altered to advantage. The position of infantile atrophy and malnutrition between scurvy and rheumatism is strange. The chapter on the mechanism of suckling should, perhaps, call attention to the fact that the infant need not suspend respiration when swallowing, the larynx protruding into the pharynx, permitting the milk to run around it into the esophagus. The author prefers rather numerous nursings, but without great insistence. One important feature in favor of a smaller number of meals has not been given, which is the greater opportunity it affords the mother for rest and play. While it is recognized that the fat content of the foremilk and the strippings may be very different, the importance of this fact for the technic of nursing under certain conditions and for the withdrawal of the milk for analysis is not recognized. The fat soluble A and the water soluble B, accessory food stuffs (or vitamins), might be mentioned. It is a great relief to have it in bold print that neither the so-called percentage method of feeding nor the caloric method of feeding are really methods of feeding. For the collection of specimens of urine from female infants the Spicer cup has proved very serviceable. Fortunately, the author is not afraid to recommend the use of alcohol where he regards it of benefit. Hydrotherapy receives more attention than in most textbooks, a distinct advantage which might even be carried further. When giving cold baths to reduce fever it must be emphasized that the surface of the body is to be massaged to prevent the contraction of the peripheral vessels. Psychotherapy, mechanotherapy, including massage, gymnastic movements, correction of faulty posture, light treatment, etc., might be treated even more generously. A little more attention to hese very helpful herapeutic agents in medical schools and in medical books intended for the practising physician would do more to counteract so-called "therapeutic" fads than any amount of talking and writing. The means by which artifical respirations can be carried on for long periods of time, such as those introduced by Meltzer and others, should have found their way into books of this kind by now. The chapter on vaccination neglects the work of Pirquet entirely and misses the significance of the early reaction on revaccination. The chapter on scorbutus neglects too much new and valuable work done after the report of the collective investigation of the American Pediatric Society had appeared (1898). The treatment of pyloric stenosis should include the feeding with thick cereal. The classification of gastro-intestinal disorders is a field open to all and no classification will satisfy many more people than its author. The *Ameba coli* may be the cause of tropical dysentery in volume 1, page 748, while on page 832, in the same volume, its presence is of doubtful significance. The discussion of the treatment of constipation by drugs should be submitted to a pharmacologist for revision. The priority for the recognition of a duodenal ulcer in infants belongs to Helmholz. Spasmophilia, tetany and laryngismus stridulus might better be discussed under one heading. The so-called functional neuroses of children are dealt with in the usual manner. The descriptions are given in a more or less general way. Here therapy can accomplish much, but more detail has to be given. Short descriptions of cases take the place which is given in the discussion of other diseases to fever charts, roentgen-ray pictures, etc.

In conclusion, it must be stated that the volumes contain a wealth of good sound information; they are a credit to the author and of distinct service to the physician interested in pediatrics.